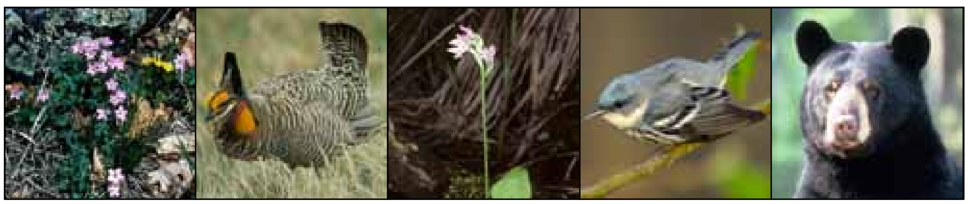
Chapter 11
Forest Transition Ecological Landscape




Where to Find the Publication

The Ecological Landscapes of Wisconsin publication is available online, in CD format, and in limited quantities as a hard copy. Individual chapters are available for download in PDF format through the Wisconsin DNR website (http://dnr.wi.gov/, keyword "landscapes"). The introductory chapters (Part 1) and supporting materials (Part 3) should be downloaded along with individual ecological landscape chapters in Part 2 to aid in understanding and using the ecological landscape chapters. In addition to containing the full chapter of each ecological landscape, the website highlights key information such as the ecological landscape at a glance, Species of Greatest Conservation Need, natural community management opportunities, general management opportunities, and ecological landscape and Landtype Association maps (Appendix K of each ecological landscape chapter). These web pages are meant to be dynamic and were designed to work in close association with materials from the Wisconsin Wildlife Action Plan as well as with information on Wisconsin's natural communities from the Wisconsin Natural Heritage Inventory Program.

If you have a need for a CD or paper copy of this book, you may request one from Dreux Watermolen, Wisconsin Department of Natural Resources, P.O. Box 7921, Madison, WI 53707.



Photos (L to R): Bedrock Glade, Eric Epstein, Wisconsin DNR; Greater Prairie-chicken, U.S. Fish and Wildlife Service; round-leaved orchis, Thomas Meyer, Wisconsin DNR; Cerulean Warbler, Dennis Malueg; American black bear, Herbert Lange.

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Cover Photos

Top left: *Several glacial end moraines occur at the margins of the Forest Transition Ecological Landscape. The Chippewa Moraine is characterized by extensive forests and rough topography, with numerous lakes and wetlands occupying the depressions. Chippewa County. Photo by Eric Epstein, Wisconsin DNR.*

Bottom left: *Much of the Forest Transition Ecological Landscape supported mesic hemlock-hardwood forests, sometimes with a supercanopy of huge eastern white and red pines. Such forests were formerly widespread and common across northern Wisconsin, but today they are very rare and continue to decline. Menominee County. Photo by Eugene Sanborn, Wisconsin Conservation Department.*

Top right: *Canopy dominants of dry-mesic forests in the westernmost part of the Forest Transition Ecological Landscape may include northern red and white oaks. Older, more extensive stands of this natural community provide important habitat for sensitive birds, especially the Wisconsin Threatened Cerulean Warbler. Managers have run a light groundfire through this mesic oak forest to reduce the growth of competing mesophytic hardwood saplings and shrubs. Polk County, near Osceola. Photo by Eric Epstein, Wisconsin DNR.*

Bottom right: *Kettle bog complex includes softwater seepage lake, poor fen, conifer swamp, and small island of old-growth pine forest. Tula Lake, Polk County. Photo by Eric Epstein, Wisconsin DNR.*


Wisconsin DNR staff

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Size

This ecological landscape encompasses 7,279 square miles (4,658,498 acres), representing 12.9% of the area of the state, making it Wisconsin's fourth largest ecological landscape.

Climate

Because the Forest Transition Ecological Landscape extends east-west for 200 miles across much of Wisconsin, the climate is variable. In addition, it straddles a major ecoclimatic zone (the "Tension Zone") that runs southeast-northwest across the state. The mean growing season is 133 days, mean annual temperature is 41.9°F, mean annual precipitation is 32.6 inches, and mean annual snowfall is 50.2 inches. The growing season is long enough that agriculture is viable, although climatic conditions are not as favorable for many crops as they are in southern Wisconsin.

Bedrock

Throughout most of the Forest Transition Ecological Landscape, the uppermost layer of bedrock is Precambrian volcanic and metamorphic rock. Precambrian bedrock underlies the eastern portion of the ecological landscape, roughly east of U.S. Highway 13, and also underlies a small area at the far western end in Polk County. A large area in the west-central part is underlain by Cambrian sandstones with inclusions of dolomite and shale. A small area in Polk County is underlain by Ordovician dolomite.

Geology and Landforms

The Forest Transition was entirely glaciated. The central portion was formed by older glaciations, both Illinoian and pre-Illinoian, while the eastern and western portions are covered by deposits of the Wisconsin glaciation. Glacial till is the major type of material deposited throughout, and the prevalent landforms are till plains or moraines. Throughout the area, postglacial erosion, stream cutting, and deposition formed floodplains, terraces, and swamps along major rivers.

Soils

Most soils are non-calcareous, moderately well-drained sandy loams derived from glacial till, but there is considerable diversity in the range of soil attributes. The area includes sandy soils formed in outwash as well as organic soils and loam and silt loam soils on moraines. There are many areas with shallow soils. Drainage classes range from poorly drained to excessively drained. Density of the till is generally high enough to impede internal drainage, so there are many lakes and wetlands in parts of the Forest Transition (e.g., in those that were more recently glaciated). Soils throughout the ecological landscape have silt loam surface deposits formed in aeolian loess, which is about 6 to 24 inches thick in much of the area.

Hydrology

Major river systems draining the Forest Transition Ecological Landscape include the Wolf, Wisconsin, Black, Chippewa, and St. Croix. Lakes and wetlands are common and extensive in some areas.

Current Land Cover

Land cover is highly variable by subsection, dominant landform, and major land use. The eastern part of the ecological landscape remains heavily forested, the central portion is dominated by agricultural uses (with most of the historically abundant mesic forest cleared), and the west end is a mixture of forest, lakes, and agricultural land.

Socioeconomic Conditions

The counties included in this socioeconomic region are Washburn, Polk, Barron, Chippewa, Taylor, Clark, Wood, Marathon, Lincoln, Langlade, Menominee, Shawano, Wood, Portage, and Waupaca.

Population

The population in 2010 was 649,922, 11.4% of the state total.

Population Density

51 persons per square mile

Per Capita Income

$29,814

Important Economic Sectors

Government, Manufacturing (non-wood), Health Care and Social Services, and Retail Trade sectors provided the highest number of jobs in 2007. Agriculture (including commercial ginseng farms) is now the dominant land use in many areas that historically supported mesic forest. Timber and paper production and recreational uses are highly significant in some parts of the Forest Transition Ecological Landscape.

Public Ownership

About 6% of land in the Forest Transition Ecological Landscape is in public ownership and includes county, state, and federally managed areas. There are portions of the Chequamegon-Nicolet National Forest; scattered state-owned lands including state parks, wildlife areas, fishery areas, and state natural areas; and portions of the Barron, Burnett, Chippewa, Clark, Eau Claire, Langlade, Lincoln, Marathon, Polk, Rusk, Sawyer, Taylor, and Washburn county forests that occur in this ecological landscape. A map showing public land ownership (county, state, and federal) and private lands enrolled in the forest tax programs can be found in Appendix 11.K at the end of this chapter.

Other Notable Ownerships

A large part of the Menominee Indian Reservation is in the Forest Transition Ecological Landscape, and these tribal lands (along with some of the adjoining publicly owned forests) constitute the largest block of contiguous forest in this ecological landscape.

Considerations for Planning and Management

The Forest Transition stretches east to west across most of Wisconsin and is mostly north of the Tension Zone and quite heterogeneous. This ecological landscape has lost over half of its historic forests (though this is highly variable in different areas) and overall is one of the most deforested ecological landscapes north of the Tension Zone. Areas to the east remain heavily forested, the central areas are open and intensively farmed, and the western end is a mosaic of agricultural land, forest, and recreational lands. West of the Green Bay Lobe Stagnation Moraine Subsection, the vegetation in much of this ecological landscape is highly fragmented, limiting most forest and grassland habitats and large-scale management opportunities (see the "Landtype Associations of the Forest Transition" map in Appendix 11.K at the end of this chapter). Large power dams occur on several of the major rivers, including the Wisconsin, Chippewa, and St. Croix. Public ownership is uneven and concentrated along several of the larger rivers as well as in some of the more heavily forested areas.

Management Opportunities

Once almost completely forested, the Forest Transition's largest blocks of forests are now limited to certain areas. Portions of two large forested areas, the Lakewood-Laona District of the Chequamegon-Nicolet National Forest and the Menominee Indian Reservation, comprise the eastern and most densely forested part of the ecological landscape. These are largely mesic forests, and the forests of the Menominee Reservation have retained some ***old forest*** attributes, including large trees, coarse woody debris, and multi-layered canopies. Unlike many other parts of Wisconsin, eastern hemlock remains abundant in some areas, and both eastern hemlock and northern white-cedar, another browse-sensitive species, can be found reproducing here. These forests provide important habitats because of their extent and condition that are rare or absent elsewhere and offer excellent opportunities for monitoring and research.

Roughly 200 miles west of the Menominee Reservation, at the westernmost end of the ecological landscape, forests also occur in relatively large blocks. These forests are very different, are generally less contiguous, and are largely dry-mesic. They can contain strong northern red and white oak components, and scattered areas contain significant amounts of eastern white pine. These forests offer opportunities to identify, manage, and protect high conservation value areas, reduce fragmentation, and conserve rare forest interior birds, and they may be important for long-term monitoring since they can contain species at their northernmost range limits as well as habitat specialists.

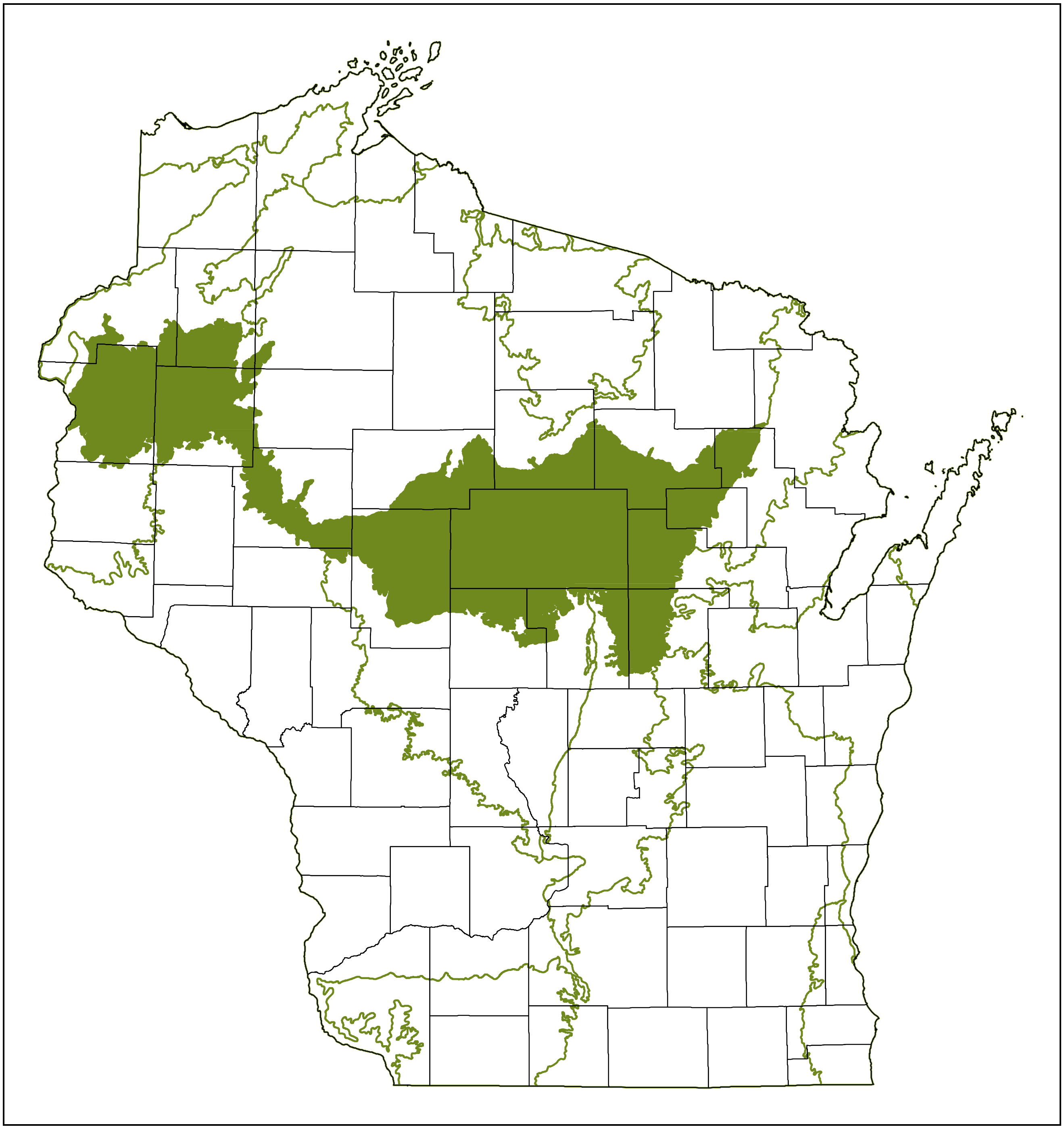
Unlike other northern Wisconsin ecological landscapes, the forests here have been significantly fragmented by widespread agricultural activities. Here the St. Croix River is flanked by a continuous corridor of steep forested bluffs, offering critical habitat to many migratory and resident animals and helping to maintain high water quality in this exceptionally diverse riparian ecosystem. Cedar Bend, near Osceola, Polk County. Photo by Mike Mossman, Wisconsin DNR.

Much of this ecological landscape, especially the center, is now quite open and dominated by intensive agricultural uses. A few open areas of surrogate grassland (nonnative grasses) and adjacent wetlands embedded within agricultural lands are large enough to support declining grassland birds, including the Wisconsin Threatened Greater Prairie-Chicken. There are opportunities to maintain, enlarge, and connect these habitats to better support area-sensitive grassland species. However, other open areas provide reforestation opportunities to increase the size of forested blocks, provide habitat for forest interior species, improve water quality, reduce hard edges, and help local economies over the long-term.

Protecting undeveloped lakes, ponds, and streams is a major opportunity in the Forest Transition. Lakes and wetlands on the Chequamegon-Nicolet National Forests associated with the Green Bay Glacial Lobe can be somewhat calcareous, and some of these alkaline waters and wetlands support rare or otherwise unusual plants. The westernmost portion of the ecological landscape contains numerous lakes associated with the St. Croix Moraine. Extensive wetlands, most of them forested, occur at the southern margins of several end moraines.

Maintaining intact river corridors is a major opportunity in the Forest Transition Ecological Landscape. A number of major rivers cross the ecological landscape from north to south, including the Wolf, Chippewa, and St. Croix, all of which support high aquatic biodiversity and many rare species. Wetlands and adjoining forests forming the corridors of these rivers are used heavily by migratory birds and may be important for other species traveling between northern and southern Wisconsin. Habitats such as floodplain forest and marsh are better represented along the large rivers than elsewhere in the ecological landscape.

Bedrock exposures, though localized and uncommon, can provide specialized habitats. Significant outcroppings of Precambrian rock in the Forest Transition Ecological Landscape include exposures of granites, quartzite, and basalt as cliffs, glades, and talus slopes in certain areas. Cambrian sandstone exposures occur at a few locations, such as the south central part of the ecological landscape.



Forest Transition Ecological Landscape

Eric Epstein, WDNR

Forest Transition Ecological Landscape

Introduction

This is one of 23 chapters that make up the Wisconsin DNR's publication *The Ecological Landscapes of Wisconsin: An Assessment of Ecological Resources and a Guide to Planning Sustainable Management*. This book was developed by the Wisconsin DNR's Ecosystem Management Planning Team and identifies the best areas of the state to manage for natural communities, key habitats, aquatic features, native plants, and native animals from an ecological perspective. It also identifies and prioritizes Wisconsin's most ecologically important resources from a global perspective. In addition, the book highlights socioeconomic activities that are compatible with sustaining important ecological features in each of Wisconsin's 16 ecological landscapes.

The book is divided into three parts. Part 1, "Introductory Material," includes seven chapters describing the basic principles of ecosystem and landscape-scale management and how to use them in land and water management planning; statewide assessments of seven major natural community groups in the state; a comparison of the ecological and socioeconomic characteristics among the ecological landscapes; a discussion of the changes and trends in Wisconsin ecosystems over time; identification of major current and emerging issues; and identification of the most significant ecological opportunities and the best places to manage important natural resources in the state. Part 1 also contains a chapter describing the natural communities, aquatic features, and selected habitats of Wisconsin. Part 2, "Ecological Landscape Analyses," of which this chapter is part, provides a detailed assessment of the ecological and socioeconomic conditions for each of the 16 individual ecological landscapes. These chapters identify important considerations when planning management actions in a given ecological landscape and suggest management opportunities that are compatible with the ecology of the ecological landscape. Part 3, "Supporting Materials," includes appendices, a glossary, literature cited, recommended readings, and acknowledgments that apply to the entire book.

This publication is meant as a tool for applying the principles of ecosystem management (see Chapter 1, "Principles of Ecosystem and Landscape-scale Management"). We hope it will help users better understand the ecology of the different regions of the state and help identify management that will sustain all of Wisconsin's species and natural communities while meeting the expectations, needs, and desires of our public and private partners. The book should provide valuable tools for planning at different ***scales***, including master planning for Wisconsin DNR-managed lands, as well as assist in project selection and prioritization.

Many sources of data were used to assess the ecological and socioeconomic conditions within each ecological landscape. Appendix C, "Data Sources Used in the Book" (in Part 3, "Supporting Materials"), describes the methodologies used as well as the relative strengths and limitations of each data source for our analyses. Information is summarized by ecological landscape except for socioeconomic data. Most economic and demographic data are available only on a political unit basis, generally with counties as the smallest unit, so socioeconomic information is presented using county aggregations that approximate ecological landscapes unless specifically noted otherwise.

Rare, declining, or vulnerable species and natural community types are often highlighted in these chapters and are given particular attention when Wisconsin does or could contribute significantly to maintaining their regional or global abundance. These species are often associated with relatively intact natural communities and aquatic features, but they are sometimes associated with cultural features such as old fields, abandoned mines, or dredge spoil islands. Ecological landscapes where these species or community types are either most abundant or where they might be most successfully restored are noted. In some cases, specific sites or properties within an ecological landscape are also identified.

Although rare species are often discussed throughout the book, "keeping common species common" is also an important

Terms highlighted in green are found in the glossary in Part 3 of the book, "Supporting Materials." Naming conventions are described in Part 1 in the Introduction to the book. Data used and limitation of the data can be found in Appendix C, "Data Sources Used in the Book," in Part 3.

consideration for land and water managers, especially when Wisconsin supports a large proportion of a species' regional or global population or if a species is socially important. Our hope is that the book will assist with the regional, statewide, and landscape-level management planning needed to ensure that most, if not all, native species, important habitats, and community types will be sustained over time.

Consideration of different scales is an important part of ecosystem management. The 16 ecological landscape chapters present management opportunities within a context of ecological functions, natural community types, specific habitats, important ecological processes, localized environmental settings, or even specific populations. We encourage managers and planners to include these along with broader landscape-scale considerations to help ensure that all natural community types, ***critical habitats***, and aquatic features, as well as the fauna and flora that use and depend upon them, are sustained collectively across the state, region, and globe. (See Chapter 1, "Principles of Ecosystem and Landscape-scale Management," for more information.)

Locations are important to consider since it is not possible to manage for all species or community types within any given ecological landscape. Some ecological landscapes are better suited to manage for particular community types and groups of species than others or may afford management opportunities that cannot be effectively replicated elsewhere. This publication presents management opportunities for all 16 ecological landscapes that are, collectively, designed to sustain as many species and community types as possible within the state, with an emphasis on those especially well represented in Wisconsin.

This document provides useful information for making management and planning decisions from a landscape-scale and long-term perspective. In addition, it offers suggestions for choosing which resources might be especially appropriate to maintain, emphasize, or restore within each ecological landscape. The next step is to use this information to develop landscape-scale plans for areas of the state (e.g., ecological landscapes) using a statewide and regional perspective that can be implemented by field resource managers and others. These landscape-scale plans could be developed by Wisconsin DNR staff in cooperation with other agencies and nongovernmental organizations (NGOs) that share common management goals. Chapter 1, "Principles of Ecosystem and Landscape-scale Management," in Part 1 contains a section entitled "Property-level Approach to Ecosystem Management" that suggests how to apply this information to an individual property.

How to Use This Chapter

The organization of ecological landscape chapters is designed to allow readers quick access to specific topics. You will find some information repeated in more than one section, since our intent is for each section to stand alone, allowing the reader to quickly find information without having to read the chapter from cover to cover. The text is divided into the following major sections, each with numerous subsections:

- Environment and Ecology
- Management Opportunities for Important Ecological Features
- Socioeconomic Characteristics

The "Environment and Ecology" and "Socioeconomic Characteristics" sections describe the past and present resources found in the ecological landscape and how they have been used. The "Management Opportunities for Important Ecological Features" section emphasizes the ecological significance of features occurring in the ecological landscape from local, regional, and global perspectives as well as management opportunities, needs, and actions to ensure that these resources are enhanced or sustained. A statewide treatment of integrated ecological and socioeconomic opportunities can be found in Chapter 6, "Wisconsin's Ecological Features and Opportunities for Management."

Summary sections provide quick access to important information for select topics. "Forest Transition Ecological Landscape at a Glance" provides important statistics about and characteristics of the ecological landscape as well as management opportunities and considerations for planning or managing resources. "General Description and Overview" gives a brief narrative summary of the resources in an ecological landscape. Detailed discussions for each of these topics follow in the text. Boxed text provides quick access to important information for certain topics ("Significant Flora," "Significant Fauna," and "Management Opportunities").

Coordination with Other Land and Water Management Plans

Coordinating objectives from different plans and consolidating monetary and human resources from different programs, where appropriate and feasible, should provide the most efficient, informed, and effective management in each ecological landscape. Several land and water management plans dovetail well with *The Ecological Landscapes of Wisconsin*, including the Wisconsin Wildlife Action Plan; the Fish, Wildlife, and Habitat Management Plan; the Wisconsin Bird Conservation Initiative's (WBCI) All-Bird Conservation Plan and Important Bird Areas program; and the *Wisconsin Land Legacy Report*. Each of these plans addresses natural resources and provides management objectives using ecological landscapes as a framework. Wisconsin DNR ***basin*** plans focus on the aquatic resources of water basins and watersheds but also include land management recommendations referencing ecological landscapes. Each of these plans was prepared for different reasons and has a unique focus, but they overlap in many areas. The ecological management opportunities provided in this book are consistent with the objectives provided in many of these plans. A more thorough discussion of coordinating land and water management plans is provided in Chapter 1, "Principles of Ecosystem and Landscape-scale Management," in Part 1 of this publication.

General Description and Overview

The Forest Transition Ecological Landscape lies along the northern border of Wisconsin's ***Tension Zone***, through the central and western part of the state, and supports both northern forests and agricultural areas. The central portion of the Forest Transition lies primarily on a glacial till plain deposited by glaciation between 25,000 and 790,000 years ago. The eastern and western portions are on moraines of the Wisconsin glaciation from 14,000 to 18,000 years ago. The growing season in this part of the state is long enough that agriculture is viable, although climatic conditions are not as favorable for crops as they are in southern Wisconsin. Soils are diverse, ranging from sandy loams to loams or shallow silt loams and from poorly drained to well drained.

The ***historical vegetation*** of the Forest Transition Ecological Landscape was primarily northern hardwood and hemlock-hardwood forests. These mesic forests were dominated by sugar maple (*Acer saccharum*) and eastern hemlock (*Tsuga canadensis*) and contained some yellow birch (*Betula alleghaniensis*), red pine (*Pinus resinosa*), and eastern white pine (*Pinus strobus*). Currently, 44% of this ecological landscape is forested compared to 86% forested before Euro-American settlement. Forested areas now consist primarily of northern hardwoods and aspen (*Populus* spp.), with smaller amounts of oak (*Quercus* spp.) and lowland hardwoods. Coniferous and deciduous swamps are scattered throughout the ecological landscape and are often found near the headwaters of streams or associated with lakes in kettle depressions on moraines. The eastern portion of the ecological landscape differs from the remainder as it is still primarily forested and includes numerous ecologically significant areas, some of them extensive. The ecological landscape's flora shows characteristics of both northern and southern Wisconsin, corresponding to its position along the northern margins of the Tension Zone (Curtis 1959).

Small ***kettle lakes*** are common on the moraines in the western and eastern parts of the ecological landscape, but there are few lakes in the central glacial till plain. Several streams have their headwaters in the moraines. Many small creeks and rivers flow across the plain including the Big Rib, Little Rib, Trappe, and Wisconsin rivers. A short stretch of the St. Croix River forms the western boundary of this ecological landscape. Water quality of the lakes, rivers, and streams varies greatly from one watershed to another and even within a given watershed. Water quality rankings range from "poor" to "excellent" and generally correlate with the type and relative intensity of land use and land cover. Streams flowing through watersheds with predominantly agricultural land uses generally have lower water quality. Lakes, rivers, and streams in watersheds with more forest cover and less urban, agricultural, or better-buffered land uses tend to have higher water quality.

The ecological landscape's total land area is approximately 4.7 million acres. About 6% is in public ownership and includes county, state, and federally managed areas.

The Forest Transition counties are quite diverse socioeconomically. Several counties stand out as top state agricultural producers. Clark and Marathon counties lead in milk production, and Portage County leads in potato, pea, and snap bean production. This region has the third highest number of fishery and wildlife areas compared with other ecological landscapes in the state. Less ***timberland*** is sold or diverted to other uses here compared to the state average. There is a fairly high per capita water use, mostly for industrial and thermoelectric power generation. Population density is slightly less than half (51 persons per square mile) than that of the state as a whole (105 persons per square mile). The population is younger on average, less racially diverse, and has attained less high school and college education compared to other regions. It has the second lowest percentage of high school and college graduates among ecological landscapes. Economically, it ranks near average for all indicators. The manufacturing sector has a relatively more important role, while the percentage of service and government jobs is somewhat below average.

Environment and Ecology

Physical Environment

Size

The Forest Transition Ecological Landscape encompasses 7,279 square miles (4,658,498 acres), 12.9% of the state's total area, making it the fourth largest ecological landscape in the state.

Climate

Climate data were analyzed from 21 weather stations within the Forest Transition Ecological Landscape: Amery, Antigo, Bloomer City Hall, Couderay, Cumberland, Curtiss, Eau Pleine Reservoir, Goodrich, Lakewood, Luck, Medford, Merrill, Neillsville, Owen, Rib Falls, Rice Lake, Rosholt, Stanley, Stratford, Waupaca, and Wausau (WSCO 2011). The Forest Transition has a continental climate, with cold winters and warm summers. Overall, the climate is similar to other ecological landscapes in northern Wisconsin (Northwest Lowlands, Northwest Sands, Superior Coastal Plain, North Central Forest, Northern Highland, and Northern Lake Michigan Coastal) except that it has a longer growing season and is slightly warmer with slightly more precipitation and less snow than other northern ecological landscapes. The northern ecological landscapes in Wisconsin generally have shorter growing seasons, cooler summers, colder winters, and less precipitation than the ecological landscapes farther to the south. Ecological landscapes adjacent to the Great Lakes generally tend to have warmer winters, cooler summers, and higher precipitation, especially snow. Because the Forest Transition extends over a large longitudinal range from eastern to western Wisconsin, the climate is somewhat variable. In addition, the Forest Transition straddles the Tension Zone, which is a major climatic division running southeast-northwest across the middle of the state (Curtis 1959).

The growing season averages 133 days (base 32°F) in length, ranging from 108 to 152 days. There is considerable variation in the number of growing degree days within the ecological landscape. These differences tend to follow a latitudinal gradient. Generally, weather stations in the northern part of the ecological landscape report fewer growing degree days (e.g., Couderay and Lakewood, with 108 and 116 growing degree days, respectively), and stations in the southern part of the ecological landscape report more (e.g., Cumberland, Wausau, and Waupaca, with 151, 151, and 152 growing degree days, respectively). However, local topography can also have an influence on growing degree days. The mean growing degree days for the Forest Transition Ecological Landscape is more than 12 days longer than other northern ecological landscapes, excluding the Northern Lake Michigan Coastal, which is affected by Lake Michigan (140 growing degree days). The growing season here is long enough for row crop agriculture to be successful, unlike ecological landscapes farther north.

The average annual temperature is 41.9°F (varies from 41 to 45°F), with less than 4°F variation in average monthly temperatures among weather stations within the Forest Transition. The general pattern of temperatures follows the latitudinal gradient described above. The average January minimum temperature is -1°F, similar to other ecological landscapes in northern Wisconsin (-1.6°F). The average August maximum temperature is 80°F, similar to other northern ecological landscapes.

Annual precipitation averages 32.6 (31.5–34.5) inches, one inch more than other ecological landscapes in northern Wisconsin. Mean annual snowfall for the Forest Transition is 50.2 inches, more than 7 inches less than other northern Wisconsin ecological landscapes (excluding the Superior Coastal Plain because it is influenced by Lake Superior). Snowfall varies considerably (more than 24 inches) among weather stations within the ecological landscape, ranging from 40.3 inches in Medford to 64.7 inches in Lakewood. These differences are most likely due to the large east-west distance encompassed within this ecological landscape and local topography.

There is an adequate growing season and enough precipitation to support agricultural row crops (such as corn), small grains, and pastures, which are prevalent land uses in many parts of this ecological landscape. However, growing conditions in the Forest Transition are not as favorable for row crop agriculture as in southern Wisconsin. The climate is also favorable for surrogate grasslands and the northern hardwood and hemlock-hardwood forests that are found here.

Bedrock Geology

The Forest Transition Ecological Landscape is large and diverse, and many parts of its geology have not been thoroughly investigated. There is not a compiled source that provides information about bedrock for the entire area, but several regional maps are available through the Wisconsin Geological and Natural History Survey, and there are detailed bedrock geology maps for Marathon, Portage, and Wood counties.

Throughout most of this ecological landscape, the uppermost layer of bedrock is Precambrian volcanic and metamorphic rock. Precambrian bedrock underlies the eastern portion of the ecological landscape, roughly east of State Highway 13, and also underlies a small area at the far western end in Polk County. A large area in the west-central part of the Forest Transition is underlain by Cambrian sandstones with inclusions of dolomite and shale. A small area in Polk County is underlain by Ordovician dolomite. See the map "Bedrock Geology" in Appendix G, "Statewide Maps," in Part 3, "Supporting Materials." (Nomenclature used herein is according to the Wisconsin Geological and Natural History Survey Open-File Report *Bedrock Stratigraphic Units in Wisconsin;* WGNHS 2006).

Bedrock of the Precambrian Shield warps upward to form the ***Wisconsin Dome***, centered under the Northern Highland Ecological Landscape. The Precambrian bedrock surface slopes down away from the Wisconsin Dome in all directions, so its elevation is lower in the western part of the Forest Transition, and more recent rock deposits lie above it there. The Precambrian Shield has a complex history because these rocks are more than one billion years old and have been subject to considerable metamorphism, erosion, and mixing during their existence (Schultz 2004). The Precambrian Shield is made up of many different kinds of rocks; granite and basalt are abundant, and rocks similar in composition to granite are present, including gneiss, diorite, monzonite, syenite, and rhyolite. Anorthosite, with a composition much like basalt, is also common. Other rocks include gabbro, schists, slate, argillite, and quartzite. Part of the complexity of the Precambrian Shield is that rocks of different types and ages do not occur in an orderly and systematic fashion as is often seen in the Paleozoic limestones and sandstones where more recent deposits lie above older ones. Also, there are almost no Precambrian-age fossils to help identify a sequence of geologic events. For these reasons, there is still much that is unknown about the Precambrian Shield.

Crystalline rock of the Precambrian Shield began forming during the early Precambrian, also known as the Archean Eon, at around 2,800 million years ago. The first rocks were created by volcanic action that occurred beneath oceans, eventually forming islands above the water's surface and subsequently eroding to produce particles that became sedimentary rocks (Dott and Attig 2004, Schultz 2004). About 1,850 million years ago, an arc of volcanic islands collided with the early land mass that eventually became the North American continent. The collision affected a zone that stretches across northern Wisconsin from Osceola on the west to Niagara on the east. Earth's crust was folded, crumpled, and forced upward; geologists refer to this event as the "Penokean mountain building episode," or the "Penokean Orogeny" (Dott and

Attig 2004, Syverson 2007). Collision and metamorphism allowed intrusions of older granitic rocks to reach the surface; granite is a lighter rock than most others and tends to "float" to the surface when there is an opening in Earth's crust.

At around 1.1 billion years ago, in a process known as rifting, the continent was nearly torn apart. Volcanic eruptions and lava flows occurred in northwest Wisconsin and Upper Michigan over about 20 million years, producing the basalt and rhyolite that outcrops in the Penokee Range and underlies Polk County (Johnson 2000, Dott and Attig 2004). After the volcanic episode, Earth's crust slowly subsided due to the weight of the accumulated cooling lava. After the period of subsidence, at about one billion years ago, a distant continental collision in eastern North America produced compressive forces that uplifted the central part of the rift and exposed volcanic rocks of the Penokees as well as those in Polk County and other locations in northwest Wisconsin and adjacent states (LaBerge 1994, Dott and Attig 2004).

There are many exposures of Precambrian rock in the ecological landscape. Impressive basalt cliffs and potholes can be viewed at the dalles of the St. Croix River, at Interstate State Park just south of the city of St. Croix Falls in Polk County. Basalt outcrops also occur on hills northeast of St. Croix Falls, continuing through the towns of Frederic and Clam Falls (Johnson 2000). Precambrian exposures are common in central Marathon County, particularly at Rib Mountain and Mosinee Hill (Attig and Muldoon 1989), and Archean gneiss is exposed along the Wisconsin River between Nekoosa and Stevens Point in Wood and Portage counties (Brown and Greenberg 2008, Greenberg and Brown 2008). In Lincoln County, Precambrian rock is exposed along the Wisconsin River near Grandfather Falls (T33N, R6E, Sec. 30-31) and along the Prairie River where the Prairie Dell Dam was removed in 1992 (T32N, R7E, Sec. 13) (Ham and Attig 1997). In Chippewa County, Precambrian metamorphic and igneous rocks are exposed in the major river valleys.

Precambrian quartzite underlies the ecological landscape in Barron County adjacent to the Blue Hills. The Barron Quartzite outcrops in the Blue Hills (which is part of the North Central Forest Ecological Landscape) but also underlies Paleozoic rock in parts of Barron, Rusk, and Sawyer counties, with a few outliers in Washburn County (Johnson 1986). Quartzite also underlies parts of Portage and Wood counties, notably areas near Powers Bluff between Wisconsin Rapids and Marshfield. The quartzite formations are believed to have originated from an extensive deposit of quartz sand at about 1,700 million years ago, part of the same deposit that formed quartzite in the Baraboo Hills and as far away as southwest Minnesota (Dott and Attig 2004). The formations are reddish-purple and have obvious strata of ripple marks that are typically seen when sand is deposited from oceans. The oceans apparently persisted over a long period of time, as quartzite at the Baraboo Hills is 4,000 feet thick.

The Wolf River Batholith is an important geologic feature that underlies the east end of the Forest Transition Ecological Landscape, including all of Menominee County (which is the Menominee Indian Reservation) and portions of Oconto, Langlade, Marathon, Shawano, Waupaca, and Portage counties. It is made up of Precambrian rock produced by volcanic activity at about 1,450 million years ago. This volcanic event occurred over a wide area, including Missouri, Colorado, and Arizona, but its cause is unknown (Dott and Attig 2004). Granitic magma from deep in the Earth's crust intruded toward the surface and cooled and crystallized at the relatively shallow depth of 1 to 2 miles (LaBerge 1994). The Wolf River rocks are dominantly granites and syenite, with smaller amounts of anorthosite and gabbro, and underlie about 3,600 square miles in Wisconsin. Outcrops are common along the Wolf River.

Cambrian sandstones are the uppermost bedrock layer throughout most of the western portion of the Forest Transition, underlying Clark, Chippewa, Barron, part of Polk, and small areas of Marathon, Wood, and Portage counties. Cambrian sandstones are more than 700 feet thick in the western part of Barron County (Johnson 1986) but thin to the east. Formations occurring in Barron and Chippewa counties, from the oldest deposit overlying Precambrian bedrock, are the Mt. Simon, Eau Claire, Wonewoc, Mazomanie/Lone Rock, St. Lawrence, and Jordan Formations (Figure 11.1). East of Barron County, the Mt. Simon and Eau Claire formations are typically the only Cambrian formations found as erosion has removed the more recent deposits (Mudrey et al. 1987, Brown 1988).

The Mount Simon Formation is the oldest Cambrian rock that lies above the Precambrian surface. It is dominantly a medium- to coarse-grained, thick-bedded sandstone but contains strata of fine-grained sandstone and shale. It was deposited from a shallow marine environment as Cambrian seas advanced over the area. The Mount Simon sandstone is up to 1,300 feet thick in parts of southern Wisconsin but thins toward the Wisconsin Dome (Schultz 2004) and is less than 470 feet thick in this ecological landscape (Mudrey et al. 1987).

The Eau Claire Formation, part of the Elk Mound Group, overlies the Mount Simon at thicknesses up to 150 feet. It was deposited in a quieter marine environment as oceans rose to a greater depth over the area. The Eau Claire is a very fine- to fine-grained, thin- to medium-bedded, light brown sandstone, fossiliferous in places, containing a large amount of shale. After this phase of deposition, the seas retreated and the surface of the Eau Claire was eroded (Schultz 2004).

Above the Eau Claire lies the Wonewoc Formation, also part of the Elk Mound Group, formed in nearshore environments and broad tidal flats as the Cambrian seas readvanced. The lower portion is fine- to medium-grained, thick-bedded, white sandstone. The upper portion is coarser-grained sandstone, white to brown, with iron staining and calcite cementation (Mudrey et al. 1987). The Wonewoc sandstone can be up to 115 feet thick in the ecological landscape but due to erosion is thinner in most places. The Wonewoc sandstone can form steep cliffs with near-vertical faces, even though the lower portion is very poorly cemented, where overlying rock protects the cliff face.

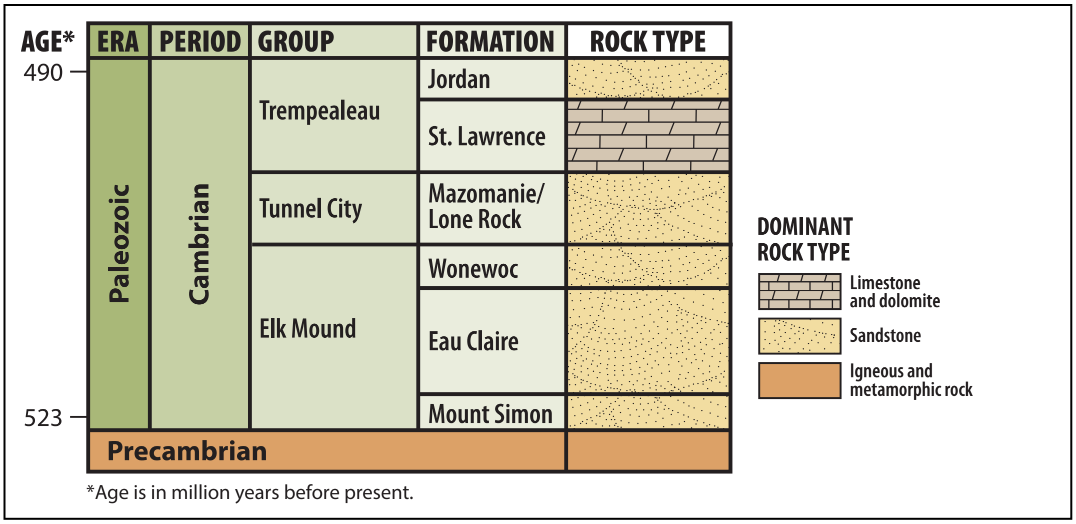


Figure 11.1. *Bedrock strata in the Forest Transition Ecological Landscape. Diagram based on Wisconsin Geological and Natural History Survey (2006).*

The Wonewoc Formation grades gradually into the overlying Tunnel City Group, which includes the Lone Rock and Mazomanie formations. Tunnel City rocks are very fine- to fine-grained and thin-bedded and up to 180 feet thick. Some strata are glauconitic (i.e., micaceous, containing an iron silicate), and the colors of different strata can be light brown, white, light gray, yellow, or greenish. Fossils of trilobites and brachiopods can be found locally in this sandstone, indicating marine deposition.

The St. Lawrence Formation, part of the Trempealeau Group, lies above the Lone Rock. It is siltstone and dolomite, less than 10 feet thick in the Forest Transition Ecological Landscape (Mudrey et al. 1987). Fossils can found in the St. Lawrence Formation but are mostly fragmented from transport before deposition.

Jordan Formation sandstone overlies the St. Lawrence Formation at a few locations in the far western part of the ecological landscape. It can also form near-vertical portions of outcrops and underlies steep slopes. It is fine- to-medium grained sandy dolomite and sandstone, up to 155 feet thick (Mudrey et al. 1987). Strata can be white, tan, yellow, or orange in color. It is the youngest formation of the Cambrian Period, deposited by the third advance of the seas. It is similar to the Mount Simon and Wonewoc formations, which were also deposited as seas were advancing over the area.

An exposure of Mt. Simon sandstone, the oldest Cambrian sandstone deposited in Wisconsin, can be seen at Irvine Park in Chippewa Falls, where it occurs above Precambrian gneissic granite in the bank of Duncan Creek (Ostrom 1978). Cambrian outcrops are also found along the St. Croix River and commonly in central Chippewa County. Neillsville Mounds at the southern edge of the ecological landscape in Clark County are Late Cambrian deposits, originally sandstone, converted to quartzite through silicification from ground water rising up along a fault.

Ordovician deposits are the youngest bedrock found in the ecological landscape. A few small deposits of Ordovician dolomite in the Prairie du Chien and Ancell Groups are located in Polk County. Ordovician rock was originally deposited throughout the state but has been eroded away over most of the Forest Transition Ecological Landscape. The presence of chert fragments weathered from dolomite of the Oneota Formation provides evidence that Ordovician deposits were formerly present in Wood and Marathon counties (Attig and Muldoon 1989, Clayton 1991).

Where this bedrock occurs, it is a resistant dolomite deposited during the Ordovician period, in the Prairie du Chien Group, including the Oneota and Shakopee Formations. The Oneota Formation consists of fine- to medium-crystalline, thin- to thick-bedded, pale gray to light brownish-gray dolomite, sandy dolomite, and dolomitic sandstone, from 140 to more than 250 feet thick. This dolomite contains cavities in which calcite and quartz has developed, and chert is also abundant. Fossils of algal reefs (Cryptozoa) are common in the dolomite, and other fossils can be found in the chert. Shakopee Formation rocks are relatively thin and contain strata of sandstone, sandy dolomite, and shale.

In a few locations they are overlain by younger rocks of the St. Peter Formation and the Sinnipee Group. Between the Prairie du Chien and the St. Peter there is a layer of red clay and chert residuum, indicating that weathering occurred for some time before deposition resumed, and the Prairie du Chien's surface is dissected by erosion (Thwaites et al. 1922, Schultz 2004). The St. Peter Formation consists of fine-to-medium grained, white to yellow quartz-rich sandstone with some limestone, shale, and conglomerate. St. Peter rock can be thick but in many areas has been partially or completely eroded.

The Wausau area has a complicated and interesting geologic history, which was described in more detail by Dott and Attig (2004, p. 65). During the time when the Wolf River

Batholith formed, a line of four volcanoes existed west of what is now Interstate 39 between Mosinee and Wausau. A mass of syenite, a volcanic rock similar to granite but with a low silica content, intruded beneath the volcanoes, producing pressure that converted sandstone to the Rib Mountain Quartzite, a resistant white-to-gray rock that forms the highest part of Rib Mountain. Intruded granitic rock is also present in this area, along with Penokean volcanic rocks and Archean gneisses.

Other than the specific outcrops and bedrock characteristics described, most of the ecological landscape is underlain by a complex assortment of Precambrian igneous and metamorphic rocks, including basalt, rhyolite, granite, gneiss, and small areas of metasedimentary rocks.

Landforms and Surficial Geology

The large size and elongated east-west shape of this ecological landscape mean that its glacial history is varied, with a considerable diversity of glacial deposits and landforms. Because of this variability, its glacial geology is described below by Subsections from the National Hierarchical Framework of Ecological Units (Cleland et al. 1997). For details on Subsections, see the "Introduction" to this publication in Part 1 and also see the "Ecological Landscapes, NHFEU Provinces, Sections, and Subsections" map in Appendix G, "Statewide Maps," in Part 3, "Supporting Materials."

The ecological landscape was entirely glaciated. The central portion was formed by older glaciations, both Illinoian and pre-Illinoian, while the eastern and western portions are deposits of the Wisconsin glaciation (Clayton et al. 1992). The Illinoian glaciation occurred between 128,000 and 310,000 years ago, and glaciations prior to that are known as pre-Illinoian. Glacial till is the major type of material deposited throughout the ecological landscape, and most landforms are till plains or moraines. Throughout the area, postglacial erosion, stream cutting, and deposition formed floodplains, terraces, and swamps along major rivers. Wind-deposited silt material (loess) formed a layer 6 to 48 inches thick.

The St. Croix Moraine Subsection (212Qa) lies farthest to the west within the ecological landscape (see the "Landtype Associations of the Forest Transition Ecological Landscape" map in Appendix 11.K as well as the "End Moraine Deposits" and the "Surficial Deposits" maps in Appendix G, "Statewide Maps," in Part 3, "Supporting Materials."). It is predominantly a moraine and associated collapsed outwash of the Sylvan Lake Member of the Copper Falls Formation. It was deposited by the southern part of the Superior Lobe during the latter part of the Wisconsin glaciation at approximately 18,500 to 15,000 years ago (time frames are uncertain due to a lack of radiocarbon dates). The Superior Lobe was melting back at the time the land surface was formed, and there are at least 12 locations in Polk County where the ice margin stalled and built small morainal ridges (Johnson 2000). On the western end of the Subsection, till is draped over a ridge of Precambrian basalt outcrops that occur northeast of St. Croix Falls and continue through the towns of Frederic and Clam Falls. Elsewhere, the till surface is hummocky due to the uneven deposition of till as it melted out of the ice sheet and from the collapse of the surface after buried stagnant ice blocks melted. Sediment deposited by braided ***proglacial*** streams formed ***pitted outwash*** (where deposited over stagnant ice) and unpitted outwash plains, terraces, and fans over much of the Subsection. Ice-walled and ice-dammed lake plains, formed from sediment deposited into glacial lakes within the ice margin, are common near the eastern edge of Polk County. Eskers were formed of gravel deposits by rivers flowing in subglacial tunnels. One notable esker lies within the margins of a former ***tunnel channel*** extending southeast from Straight Lake nearly as far as Big Round Lake.

The Sylvan Lake till that occurs at the surface is typically a non-calcareous reddish-brown sandy loam. It lies over other non-calcareous tills of previous glacial advances. The Pierce Formation, a dark grey loamy till, is thought to have been deposited at around 460,000 years ago during pre-Illinoian time. It is 10 to 65 feet thick and is not exposed within the Subsection. The River Falls Formation, from the Illinoian glaciation, lies above the Pierce Formation, but its occurrence is patchy (Johnson 2000). The Poskin Member of the Copper Falls Formation, a slightly siltier till deposited between 25,000 and 15,000 years ago, directly underlies the Sylvan Lake surface. It is typically around 50 feet thick in northwestern Barron County (Johnson 1986). Total thickness of Pleistocene sediment over bedrock is typically 100 to 150 feet. Many swamps and bogs occur in this area as a result of impeded drainage caused by the thick underlying till deposits.

The Lincoln Formation Till Plain-Mixed Hardwoods Subsection (212Qb) is a long narrow area in the central portion of the ecological landscape, extremely variable, characterized by eroded till and outwash with sandstone outcrops. It is transitional between the Wisconsin and the Illinoian glaciations, with some materials clearly linked to the Wisconsin glaciers and others of uncertain origin that could be early Wisconsin or Illinoian deposits.

Two glacial advances during the last part of the Wisconsin glaciation formed the land surface of central Barron County. The first of these was the Early Chippewa Advance by the Chippewa Lobe at sometime between 15,000 and 25,000 years ago. It moved in a southerly direction, depositing a yellowish-red, sandy loam till classified as the Pokegama Creek Member of the Copper Falls Formation. Within the same approximate time period, but later than the Early Chippewa Advance, the Superior Lobe advanced from the northwest. This was the Early St. Croix Advance (later renamed the Emerald Phase, depositing till of the Poskin Member of the Copper Falls Formation (Johnson 2000). Poskin is a yellowish-red sandy loam distinguished from other tills by its higher silt content. Ice-margin fluctuations during glacial retreat resulted in deposition of Poskin till over remnant ice blocks, which later collapsed and created valleys that now contain lakes and streams. Beneath the Copper Falls surface lies the older River Falls Formation, deposited by both the Superior and Chippewa lobes, composed of reddish-brown gravelly sandy loam. Below it lies the dark loamy till of the Pierce Formation. River Falls deposits are associated with the Illinoian glaciation, but the Pierce Formation is a much older deposit. Total thickness of Pleistocene sediment over bedrock is typically 100–150 feet in this part of the Subsection.

The land surface in Chippewa County is predominantly a sandy outwash plain associated with the Copper Falls Formation, consisting of sediment deposited by shallow braided streams flowing from both the Superior and Chippewa lobes as the ice melted. It includes islands of River Falls till as well as Cambrian sandstone outcrops and ***pediments*** (Syverson 2007).

The portion of the Subsection in southeast Chippewa and central Clark counties is an eroded till plain of the Merrill Member of the Lincoln Formation, deposited early in the Wisconsin glaciation by the Chippewa Lobe at more than 40,800 years ago. This material is believed to be younger than the River Falls Formation because it retains some distinct surface landforms, such as drumlins, even after the long period of weathering (Syverson 2007). The till is a non-calcareous, slightly gravelly, reddish-brown to brown sandy loam to loam, typically draped over sandstone bedrock uplands. Pleistocene sediment in this part of the Subsection is around 50 feet thick.

The Lincoln Formation Till Plain-Hemlock Hardwoods Subsection (212Qc) is a glaciated landscape that is predominantly a till plain of the Lincoln and Marathon formations, deposited during pre-Illinoian and Illinoian glaciations. It is dominated by till plains and is more homogenous than the Lincoln Formation Till Plain-Mixed Hardwoods Subsection. Most of the area is loamy till on eroded ground moraines of the Illinoian glaciation.

A band along the western and northern boundaries of the Subsection is made up of the eroded till plain of the Merrill Member of the Lincoln Formation, described previously. Southeast of the Merrill Member, in Chippewa, Clark, and Marathon counties, is the Edgar Member of the Marathon Formation, a yellowish-brown, slightly gravelly loam. The till was deposited by ice flowing from the north or northwest during the Milan Phase of the Illinoian glaciation and is typically 16 to 50 feet thick. It contains some carbonates, but in most areas they have been leached to depths of 7 to 16 feet below the surface. In Wood County, the Edgar till is calcareous where it overlies Precambrian bedrock but is leached where it overlies Cambrian sandstone or Pleistocene sand (Clayton 1991). Areas underlain by the Edgar till have broad, nearly flat uplands and deeply incised valleys (Attig and Muldoon 1989). Topography in southern Lincoln County is controlled by the underlying Precambrian bedrock, which is within 16 to 33 feet of the surface in uplands (Ham and Attig 1997). In northern Marathon County, the Merrill Member thins to less than 16 feet and becomes patchy at its southern limit. In the subsurface, patches of the older Medford Member of the Marathon Formation occur in locations where it was not eroded (Attig and Muldoon 1989). Subsurface Medford deposits are also noted in southeast Taylor County (Attig 1993), but their extent throughout the Subsection is uncertain. The Medford Member is a gray, calcareous till thought to have originated in Manitoba, deposited during the Stetsonville Phase of the early Wisconsin glaciation (Attig and Muldoon 1989).

The eastern tip of the Subsection, in Langlade County, has an area of undifferentiated fluvial deposits associated with the Langlade and Green Bay lobes, consisting of gravel and sandy gravel on terraces and plains. Smaller areas of outwash from proglacial streams occur throughout the Subsection along major rivers, forming outwash plains, terraces, and fans. Swamps are common due to impeded drainages from the till and underlying bedrock.

The Rib Mountain Rolling Ridges Subsection (212Qd) is mapped as the Marathon Formation, undifferentiated because these deposits cannot be associated with a particular glacial event and as such are not designated as a member. The Subsection includes central Marathon County and northern portions of Wood and Portage counties. Glacial deposits here have been considerably reworked by "hillslope processes" of erosion and mixing, including processes such as shallow soil flowage, slope wash, and creep. Some till deposits are likely included, but the sediments are thought to be mostly derived from weathering of Precambrian and Cambrian bedrock (residuum) and mixed and transported by slope processes. Patches of till of the Wausau and Edgar Members are present at scattered locations.

The undifferentiated Marathon Formation materials are slightly gravelly to gravelly loams, typically 7 to 10 feet thick over Precambrian or Cambrian bedrock, with rock outcrops common. There are several prominent bedrock-cored hills, such as Rib Mountain.

The area is complex, dissected by major drainage systems, and supports many wetlands. Stream sediments deposited during and after glaciation built landforms including outwash plains, terraces, fans, and floodplains along major rivers, including the Wisconsin River. Swamps are common throughout the Subsection due to impeded drainages from the till and underlying bedrock.

The Green Bay Lobe Stagnation Moraine Subsection (212Ta) is a glaciated area dominated by morainal and outwash head landforms interspersed with outwash plains. It includes the glacial landforms that make up the Mapleview Member of the Holy Hill Formation (the Mapleview Member was formerly included with the Horicon Formation, as referred to in Clayton [1986] and Attig and Muldoon [1989]). Landforms of the Mapleview Member were deposited along the outermost western margin of the Green Bay Lobe as it melted during the last part of the Wisconsin glaciation about 14,000 years ago (McCartney 1983). Many small glacial advances and retreats formed the land surface, so the landscape is varied and includes parallel morainal and outwash head ridges trending in a northeast-southwest direction. Outwash heads were formed as the glacier melted rapidly and deposited sand and gravel in relatively high ridges along the ice margin. These ridges were left as high points in the landscape after the ice melted. They have a similar appearance to moraines but are built of sand and gravel (Attig and Ham 1999). Much of the till deposited in till plains and moraines as the glacier advanced was buried in outwash sands and gravels that flowed from meltwater streams at the ice margin at each stage of retreat, so the morainal ridges protrude from areas of outwash-mantled till. Landforms created by meltwater stream sediments include outwash plains, both pitted and unpitted; terraces; and fans. The outwash-mantled till surface is hummocky due to the uneven deposition of till as it melted out of the ice sheet and from the collapse of the till and outwash materials after buried stagnant ice blocks melted. There are a number of ice-walled lake plains mapped within the Mapleview till in Portage and Marathon counties (Clayton 1986, Attig and Muldoon 1989). The surficial geology of Waupaca, Shawano, and Menominee counties has not been mapped at this time.

The Mapleview till is a calcareous, brown, gravelly sandy loam and loamy sand. It contains dolomite that was incorporated into the material by glacial movement across the ***Niagara Escarpment*** that borders Lake Michigan. In Portage County, carbonates have been leached from the till, typically to about 7 feet, but may be leached to depths of 23 feet depending on landscape position (Clayton 1986). Carbonate leaching in the remainder of the ecological landscape has not been reported. In the southern part of the Subsection, gravel in the till is dominantly made up of fragments of pink granitic rock derived from the Wolf River Batholith. Surface boulders of the Wolf River granite are also common in the area. Thickness of the Mapleview till is poorly known but in Marathon County is thought to typically be 33 feet thick or more, underlain by sand and gravel (Attig and Muldoon 1989). The many swamps, lakes, and bogs that occur in the Subsection are the result of impeded drainage caused by the till.

A map showing the Landtype Associations (WLTA Project Team 2002) in this ecological landscape, along with the descriptions of the Landtype Associations, can be found in Appendix 11.K at the end of this chapter.

Topography and Elevation

The lowest area in this ecological landscape occurs near the boundary with Minnesota, along the St. Croix River in Polk County, where the elevation is approximately 682 feet. The highest elevation is 1,924 feet, at Rib Mountain. Topography is typically undulating or rolling on the till plain surfaces that are predominant in the ecological landsacape but ranges from nearly level in wetlands, ice-walled lake plains, and outwash deposits to hilly and steep in moraines, bedrock-cored hills and monadnocks, and along river valleys.

Soils

Most soils in the ecological landscape are non-calcareous, moderately well-drained sandy loams derived from glacial till, but there is considerable diversity in the range of soil attributes. The area includes sandy soils formed in outwash as well as organic soils and loam and silt loam soils on moraines. There are many areas with shallow soils. Drainage classes range from poorly drained to excessively drained. Density of the till is generally high enough to impede internal drainage, so there are many lakes and wetlands in most parts of the ecological landscape. Soils throughout the ecological landscape have silt loam surface deposits formed in aeolian loess, about 6 to 24 inches thick. Soils are described below by Subsection. See the "Soils Region" map in Appendix G, "Statewide Maps," in Part 3, "Supporting Materials."

In the St. Croix Moraine Subsection (212Qa), most upland soils formed in reddish-brown non-calcareous dense sandy loam till on moraines, in loess over the till on moraines, in loamy alluvium over outwash sand and gravel on moraines and glacial drainage ways, and in loamy to silty lacustrine material on lake plains. The dominant soil in this Subsection is moderately well drained and loamy with a sandy loam surface, moderately slow permeability, and moderate available water capacity. The soils range from well drained to somewhat poorly drained and generally have sand loam to silt loam surface textures, rapid to very slow permeability, and moderate to very high available water capacity. Igneous bedrock exposures are common in the western part of the Subsection. Most lowland soils are very poorly drained acid peat or non-acid muck, while some are poorly drained outwash sands and gravels, loamy till, or lacustrine deposits. The major river valleys have soils formed in sandy to loamy alluvium or non-acid muck, drainage classes that range from moderately well drained to very poorly drained, and areas subject to periodic flooding.

In the Lincoln Formation Till Plain-Mixed Hardwoods Subsection (212Qb), most of the soils formed in outwash and in non-calcareous loamy till. The dominant soil in this Subsection is moderately well drained and loamy with a silt loam surface, moderate permeability, and moderate available water capacity. Most of the morainal upland soils on the north end of the Subsection formed in loess over reddish-brown non-calcareous dense sandy loam till. They range from well drained to somewhat poorly drained and generally have silt loam surface textures, moderate to very slow permeability, and moderate available water capacity. Most upland soils on the outwash plain in the center of the Subsection formed in loamy alluvium over outwash sand and gravel or entirely in outwash sand. They range from excessively drained to somewhat poorly drained and generally have silt loam to loamy sand surface textures, moderate to very rapid permeability, and moderate to low available water capacity. Upland soils at the southern end of the Subsection formed in brown non-calcareous loamy till on moraines and in silty to loamy alluvium over residuum from sandstone and shale on pediments. They range from moderately well drained to poorly drained and generally have silt loam to fine sandy loam surface textures, moderate to moderately slow permeability, and moderate to high available water capacity. Exposures of Paleozoic bedrock occur throughout the Subsection. Most lowland soils are very poorly drained acid peat or non-acid muck, poorly drained outwash sand and gravel, or loamy till. The major river valleys have soils formed in sandy to loamy alluvium or non-acid muck, range from moderately well drained to very poorly drained, and have areas subject to periodic flooding.

In the Lincoln Formation Till Plain-Hemlock Hardwoods Subsection (212Qc), most upland soils formed in loess over reddish-brown non-calcareous dense sandy loam till or brown non-calcareous non-dense sandy loam till on moraines and in loamy and silty alluvium over acid outwash sand and gravel on glacial drainage ways and outwash plains. The dominant soil in this Subsection is moderately well drained and loamy with a silt loam surface, moderately slow permeability, and moderate available water capacity. Soils range from moderately well drained to somewhat poorly drained and generally have silt loam surface textures, moderate to very slow permeability, and moderate available water capacity. Most lowland soils are very poorly drained non-acid muck, poorly drained outwash, or loamy till. The major river valleys have soils formed in loamy alluvium or non-acid muck, range from moderately well drained to very poorly drained, and have areas subject to periodic flooding.

In the Rib Mountain Rolling Ridges Subsection (212Qd), most soils formed in loamy residuum, a mixture of residuum and till, or in outwash. The dominant soil in this Subsection is moderately well drained and loamy with a silt loam surface, moderate permeability, and moderate available water capacity. Most upland soils formed in non-calcareous loamy till or residuum from igneous and metamorphic rock. These soils range from well drained to somewhat poorly drained and generally have silt loam to sandy loam surface textures, moderate to moderately slow permeability, and moderate available water capacity. Igneous and metamorphic bedrock exposures are common. The valleys have upland soils formed in outwash sand and gravel. They range from excessively drained to somewhat poorly drained, very rapid to moderate permeability, and low to moderate available water capacity. Most lowland soils are very poorly drained non-acid muck, poorly drained loamy till or residuum, or poorly drained outwash. The major river valleys have soils formed in loamy alluvium or non-acid muck, range from somewhat poorly drained to very poorly drained, and have areas subject to periodic flooding.

In the Green Bay Lobe Stagnation Moraine Subsection (212Ta), most soils formed in non-calcareous sandy loam and loamy sand till and in outwash. The dominant soil in this Subsection is well drained and loamy with a sandy loam surface, moderate permeability, and moderate available water capacity. Overall, the upland soils formed in loamy alluvium over acid outwash sand and gravel on moraines or outwash plains, in brown non-calcareous sandy loam and loamy sand till or mudflow sediments on moraines and drumlins, or entirely in outwash sand on outwash plains. They range from excessively drained to somewhat poorly drained and generally have sandy loam to loamy sand surface textures (loamy sand being more typical in the southern part of the Subsection), moderate to very rapid permeability, and moderate to low available water capacity. Some soils have carbonates within a 6-foot depth, but in most soils the carbonates have leached to a level below that. Most lowland soils are very poorly drained non-acid mucks or poorly drained outwash.

Hydrology

Basins

This sprawling ecological landscape occupies parts of eight major water basins, including large portions of the St. Croix, Lower Chippewa, Black River, Central Wisconsin, Wolf River, and Green Bay basins (see the "Water Basin" map in Appendix G, "Statewide maps," in Part 3 of this publication). It also covers the southern 5% of the Upper Wisconsin River basin in Taylor, Lincoln, and Langlade counties and a few square miles of the Upper Chippewa basin in northwestern Chippewa County. There are 76 watersheds lying wholly or partly within this ecological landscape, from the main stem of the St. Croix River in the west to the headwaters of the Oconto River in the east (see Appendix 11.A at the end of this chapter). The broad west-to-east geographic span of this ecological landscape includes segments of many of the most ecologically diverse rivers and streams in the state.

The major hydrologic features of the Forest Transition are clusters of lakes and small streams in the northwest (especially in Polk, Barron, and Washburn counties), the Wisconsin River and many of its central Wisconsin tributaries, another cluster of lakes in northeastern Wisconsin (in Oconto County), lengthy segments of the Big Rib, Eau Pleine, and Wolf rivers, and a short section each of the St. Croix, Black, and Chippewa rivers. Rivers, streams, lakes, and wetlands in the Forest Transition are important habitat for many rare aquatic species (see the "Fauna" section below). Many of Wisconsin's major water storage and hydropower impoundments are here as well.

Inland Lakes

According to the Wisconsin DNR's 24K Hydrography Geodatabase (WDNR 2015c), there are 923 named lakes and 1,125 unnamed lakes, with a total area of 65,280 acres, in the Forest Transition Ecological Landscape. This is the third highest total number of lakes (after only the North Central Forest and Northern Highland ecological landscapes), and the fourth largest total area in lakes (the Southeast Glacial Plains has the third greatest area of lakes), among all ecological landscapes in the state. Most unnamed lakes are small bog, kettle, or pothole lakes or shallow open water areas within wetland complexes, ranging from less than one acre in size (and often informally referred to as "ponds"), up to 20 to 40 acres or more. The remainder are oxbow and floodplain lakes within major river corridors.

The majority of natural lakes occur in the far western portion of the ecological landscape in a large band across the Chippewa Moraine, from southern Washburn County, across northwest Barron County, and throughout much of Polk County. The only other significant cluster of lakes occurs in the eastern part of the ecological landscape in glaciated terrain in

Undisturbed kettle bog complex, with softwater seepage lake, bog/poor fen, conifer swamp, and alder thicket. Glocke Lake Research Natural Area, Lakewood-Laona District, Chequamegon-Nicolet National Forest, Oconto County. Photo by Eric Epstein, Wisconsin DNR.

Residential, recreational, and agricultural development around a Forest Transition lake. Rougher topography and wetlands have limited development southeast of the lake. Photo by National Agricultural Imagery Program.

far northwest Oconto County. A few medium-sized lakes are present in the western portion of Menominee County. Small to medium-sized lakes are common farther south, especially on the relatively rough topography near the western margins of the Green Bay Lobe Stagnation Moraines.

Among the named lakes are many that are well known and heavily used for fishing, swimming, and water sports. Lakes here represent a good cross-section of lake types typical of the northern half of Wisconsin. Seepage lakes are the dominant type, and there are a fair number of drainage lakes and some spring lakes. Some lakes in the Forest Transition Ecological Landscape are not heavily impacted by development and support relatively intact aquatic plant and animal communities with high species diversity.

The larger and most prominent among Forest Transition lakes are Shell (2,580 acres), Balsam (2,054 acres), Big Round (1,015 acres), Deer (807 acres), Wapogasset (1,186 acres), Bone (1,781 acres), and Half Moon (579 acres) in Polk County; Chetac (1,920 acres) in Sawyer County; Red Cedar (1,841 acres), Pokegama (506 acres), Rice (939 acres), Prairie (1,534 acres), Chetek (779 acres), and Upper Turtle (438 acres) in Barron County; and Boot (235 acres), Archibald (393 acres), Bass (142 acres), Maiden (269 acres) and Wheeler (293 acres) in northwestern Oconto County. Several of the lakes here are really sloughs along the St. Croix River and within its floodplain. The bulk of the Chippewa Moraine lakes are within 60 to 90 minutes of the Minneapolis-St. Paul metropolitan area and are subject to heavy shoreline development pressure and high summer recreational use.

Twenty-six lakes here, all within a large cluster in Polk, Sawyer, and Barron counties, are classified as wild rice waters by Wisconsin DNR and the Great Lakes Indian Fish and Wildlife Commission for resource management purposes, within the category of Areas of Special Natural Resource Interest (ASNRI). ASNRI lakes are given some protections from shoreline development, aquatic plant harvesting, or chemical treatment in state statutes under Ch. NR 1.05, Wisconsin Administrative Code. The wild rice lakes include Spooner, Balsam, Tuscobia, Red Cedar, White Ash, McKenzie, Kekegama, Big Round, Shell, Potato, and two lakes named Rice Lake. There are no ASNRI streams in the Forest Transition.

Impoundments

There are 56,474 acres of impoundments, with a volume of 402,743 acre-feet of water, ranking the Forest Transition Ecological Landscape the sixth highest in both of these categories (WDNR 2015c). Most of the major reservoirs are in the Central Wisconsin River basin and managed by the Wisconsin Valley Improvement Corporation to store water for hydroelectric energy production. There are 590 dams remaining throughout the rest of the ecological landscape (the second largest number of dams in any ecological landscape), although more dams have been removed from the Forest Transition than any other ecological landscape in Wisconsin. Removal of 158 dams for lack of maintenance, abandonment, or for other reasons has helped restore both normal hydrologic processes and aquatic habitat connectivity to the streams they formerly impounded.

The Wisconsin River has been impounded in numerous places here, creating large flowages such as Lake DuBay (6,700 acres), Stevens Point #2 (2,093 acres), Lake Wausau (1,918 acres), and Mosinee Flowage (994 acres). Many of these impoundments, especially Lake DuBay, are popular for fishing in the summer as well as during winter. The Lake DuBay Dam also impounds the lower 7 miles of the Little Eau Pleine River.

Several Wisconsin River tributaries are also impounded. The Big Eau Pleine, Little Eau Pleine, and Eau Claire rivers have dams on them that form substantial impoundments and block fish movement from the Wisconsin River. The lower ***reaches*** of the Big Rib are backed-up by the impoundment on the Wisconsin River formed by the Rothschild Dam. Of these, the Big Eau Pleine Flowage (6,830 acres) is a ***Conservation Opportunity Area*** (WDNR 2008b) due to its value as habitat for aquatic birds as well as for its adjoining grassland habitat. However, it has chronic water quality problems and has experienced periodic fish kills due to excessive nutrient runoff from improperly applied agricultural nutrients, coupled with extensive late-winter water drawdowns by the operators of the Big Eau Pleine Dam. An especially severe fish kill occurred in March 2009, despite oxygen input from an aeration system (W.A. Smith, Wisconsin DNR personal communication).

Lake Wissota (4,113 acres) and Old Abe Lake (Jim Falls Flowage; 470 acres) are impounded stretches of the Chippewa River. The Lake Wissota Dam was constructed in 1913 by the former Wisconsin/Minnesota Power and Light Company to produce electricity. It holds nearly 130,000 acre-feet of water and has a maximum depth of 64 feet. Lake Wissota is popular with anglers for catching smallmouth bass (*Micropterus dolomieu*) and panfish. The impoundment holds a population of lake sturgeon (*Acipenser fulvescens*), but the dam blocks their movement, limiting genetic diversity with the Chippewa River population. Lake Wissota has good aquatic plant diversity, and its aquatic plant community resembles more of an undisturbed condition than most lakes in the Environmental Protection Agency's North Central Hardwood Forest region (Heuschele 2006). An improvement in the extent and composition of Lake Wissota's aquatic plant community has been attributed to the termination of significant winter water level drawdowns that used to be a common management practice. By contrast, Old Abe Lake has low plant diversity. Both of these waterbodies have been invaded by the invasive exotic aquatic macrophyte curly pondweed (*Potamogeton crispus*).

Indianhead Flowage on the St. Croix River is 776 acres. Jordan Pond, on the lower Plover River, is a modest 84 acres, but it is a popular recreation spot only a few miles northeast of Stevens Point in an area featuring a mixture of agricultural and low-density residential land uses. A survey in 2002 indicated that this small impoundment still exhibits good water quality and supports healthy numbers of a diverse assemblage of amphibian species (UWSP and PC 2005).

Mead and McMillan State Wildlife Areas in southern Marathon County each contain waterfowl flowages (impoundments) created by constructing dikes across the Little Eau Pleine River. Among the large impoundments here are Berkhahn Flowage (1,100 acres), McMillan Reservoir (690 acres), Rice Lake South Flowage (1,040 acres), Main Flowage (620 acres), Flowage #5, (336 acres), and Honey Island North Flowage (707 acres).

Rivers and Streams

Approximately 4,850 miles of perennial streams flow through this ecological landscape (WDNR 2015c). These include about 12 miles of the main stem of the St. Croix River in addition to the headwaters of several tributaries to the St. Croix; about 15 miles of the middle Chippewa between the Cornell Dam and Lake Wissota; the central Wisconsin River and a number of its important tributaries, including the Big Rib, Eau Claire, Eau Pleine, and Plover rivers; the lower Yellow River (Chippewa County); the upper halves of the Black and Red Cedar rivers; about 20 miles of the Wolf River; and the headwaters of the Yellow (Washburn County), Little Wolf, Clam, and Yellow (Wood County) rivers. Portions of all three rivers bearing the name Yellow River flow through this ecological landscape.

Nearly all the above major rivers, tributaries, and headwaters streams here support a high diversity of aquatic organisms, including species tracked by the Wisconsin Natural Heritage Inventory as endangered, threatened, and special concern as well as other Species of Greatest Conservation Need. Especially important for listed and other rare or declining aquatic invertebrate and fish species are the St. Croix, Wolf, Eau Claire, Chippewa, Red Cedar, Little Wolf, and Yellow (Chippewa County) rivers. Numerous smaller streams provide important habitat for species of special concern (W.A. Smith, Wisconsin DNR, personal communication).

Several rivers and streams in this ecological landscape have been designated as aquatic Conservation Opportunity Areas (COAs). These waters provide habitat for aquatic species that are targets of potential conservation actions under the Wisconsin Wildlife Action Plan (WDNR 2005b). The Little Rib and Big Rib, upper Little Wolf, Middle Wisconsin, and Wolf rivers are all of Upper Midwest significance. Both the St. Croix below the St. Croix Falls Dam to the ecological landscape boundary and the Plover River are COAs of state significance. The larger rivers in this ecological landscape have diverse habitats and fish communities that also support good recreational fishery opportunities, primarily for smallmouth bass, walleye (*Sander vitreus*), northern pike (*Esox lucius*), and muskellunge (*Esox masquinongy*).

Coldwater Streams. In the eastern portion of this ecological landscape, the Prairie River is one of Wisconsin's premier coldwater trout streams, featuring several miles of scenic and productive habitat restored by the removal of the Prairie Dells Dam in 1993. Its major tributaries, the North Branch Prairie River and Big Hay Meadow Creek, are also high quality trout streams. The upper Plover River, South Branch of the Embarrass River, Comet Creek, South Branch of the Embarrass, and the upper Little Wolf River are other high-quality, coldwater trout streams here.

In the east-central part of the Forest Transition, notable coldwater streams include Wood Creek and the upper Big Rib River. In 1992 portions of the Big Rib River were studied for impacts of in-stream sand and gravel mining (Lyons and Kanehl 1992). This study concluded that in-stream or adjacent floodplain sand and gravel mining had damaged riparian spawning habitat, disrupting the reproduction of both fish and aquatic invertebrates. Chippewa County, in the narrow central portion of the ecological landscape, features McCann and Duncan creeks. The impoundment of Duncan Creek by a dam in Bloomer has impaired water quality in this stream by elevating downstream temperatures and is the subject of a local restoration plan. Research on Duncan Creek upstream of the Bloomer Dam has demonstrated positive effects on

Fast flowing stretch of the Wolf River. Photo by Doug Fields.

native brook trout densities and the proportion of larger trout gained from protecting coldwater sources, past habitat restoration work, the exclusion of livestock from stream banks, and the benefits of stream ***buffers*** (Kurz 2002).

In Polk and Barron counties, in the westernmost portions of the Forest Transition, the only high-quality coldwater streams supporting trout are Parker Creek and the Hay River. Several less-productive trout waters do occur here, including Peabody, Big Rock, Osceola, Fourmile, and Dorrity creeks, and the upper Yellow River.

Coolwater Streams. The Wolf River enters this ecological landscape in Langlade County near Holister several miles downstream from its confluence with the cold waters of the Hunting River near Pearson. In this entire section, the Wolf River is a coolwater stream and is also another of Wisconsin's most valued trout streams. Despite a section of deep, fast water, much of the Wolf River here tends to be wide, shallow, and warmer than typical trout waters. This less-than-optimal habitat favors stocked and naturally reproducing but exotic brown (*Salmo trutta*) and rainbow trout (*Oncorhynchus mykiss*) more than native brook trout (*Salvelinus fontinalis*). It is popular not only for angling but also for paddle sport use. Immediately below Langlade County in the Menominee Indian Reservation, the Wolf River corridor is heavily forested with hemlock-hardwoods and valued for its ecological and aesthetic qualities. It is designated as a National Scenic Riverway south from the Langlade-Menominee county line. Within this ecological landscape, the Wolf does not support any rare fish, but it does have at least nine rare aquatic invertebrates (W.A. Smith, Wisconsin DNR personal communication). Norrie Brook, McCaslin Brook, the Little Trappe River, Drew and Mayking creeks, and numerous other coolwater streams also provide habitat for rare fish and invertebrates.

Warmwater Streams. This ecological landscape includes a portion of the St. Croix River, a warmwater river that is arguably one of the most ecologically important river systems in Wisconsin and the Upper Midwest due to its size, orientation, heavily forested corridor, and the many rare and otherwise significant species it supports. A stretch of approximately 6 miles is impounded by the St. Croix Falls dam. Below the dam, there are only about four free flowing miles of the St. Croix River within the Forest Transition Ecological Landscape, including the stretch that flows through Interstate State Park.

Interstate State Park is within the Saint Croix National Scenic Riverway and is also part of the Ice Age National Scientific Reserve. Within the park, visitors can find one of the more striking riverbed features in the state—cylindrical potholes. These potholes were formed by the grinding action of sand and small stones swirling in strong currents, eddies, and whirlpools from the torrents of water released by melting glaciers 10,000 years ago. The volume of water coming down the St. Croix River eventually lessened, water levels dropped, and many of these potholes are now exposed above the surface of the river today. Soil, vegetation, and rainwater have since collected in them, disguising their true depths. Some have been excavated; one, the Bottomless Pit, is 10 feet wide and 60 feet deep, the deepest explored pothole of this kind in the world.

The water in the St. Croix River is clear but slightly tannin stained. The stream gradient below the dam is moderate with most bottom substrates being sandy or gravelly but with a number of rocky riffles and some mild, boulder-strewn rapids. This stretch of the St. Croix provides habitat for lake sturgeon and other rare fish, rare mussels, and other rare invertebrates (see the "Fauna" section below for details). For several miles above the St. Croix Falls dam, the impounded river takes on the sluggish characteristics of a lake and has lost its riverine habitat values. However, the St. Croix still maintains good water quality because of the heavily forested and mostly undeveloped character of the river corridor and the lack of agricultural and industrial land uses within the watershed. The St. Croix Falls Dam is operated by Xcel Energy as a run-of-the-river dam to help prevent negative impacts that would result from operation as a peak power generation facility. This mode of operation is aimed at preventing abnormally large flows and uncharacteristically low flows of the river in order to help protect vulnerable fish and aquatic invertebrate species, especially mussels, and to ensure that there is sufficient water to maintain populations and life stages of sensitive aquatic organisms at all times.

Tributaries to the St. Croix River that flow through the Forest Transition include the Trade and Apple rivers. The western portion of the Trade River watershed is more forested and dotted with lakes, while the eastern portion is more agricultural, which impacts this coolwater stream somewhat. The Apple River is a fertile warmwater stream that carries excessive silt from agricultural land uses to the east.

About 16 free-flowing miles of the Chippewa River occur in the Forest Transition between the Cornell Flowage Dam and Lake Wissota, a large impoundment at Chippewa Falls. To the north of the Forest Transition, the Upper Chippewa River basin is heavily forested, contributing to clear, lightly tannin-stained water of high quality. However, impoundments on the Chippewa are impacted by algal blooms and increasing turbidity. Below the dam at Cornell, the Chippewa River has less sand and more gravel substrate than either the Black or Wisconsin rivers, although the river bottom begins to accumulate more sand and fine sediment in the tailwaters of Lake Wissota, above Chippewa Falls (WDNR 2001a). While dams block this stretch of the Chippewa from direct connection with the Mississippi River, this section does support several rare species (see the "Fauna" section below).

Before the construction of dams to facilitate transport of raw timber and lumber, which was followed by hydropower dam construction, the Wisconsin River had at least 28 documented waterfalls and rapids, and six of these were in the Forest Transition Ecological Landscape. They were Bill Cross Rapids, about a mile above the Wisconsin's confluence with the New Wood River; Jenny Bull Falls at the site of the present-day Merrill Dam; Maine's Rapids; Trappe Rapids, just upstream of the Wisconsin's junction with the Trappe River; Big Bull Falls at the Highway 52 "Falls Bridge" in Wausau; and Little Bull Falls, historically called Spruce Falls, at Mosinee.

Little Bull Falls was the most dangerous rapids on the river. Over one-half-mile long, the river roared over much of this distance in a narrow gorge only 30 feet wide. It dropped 21 feet, and for about 100 yards the pitch was estimated to be 45 degrees. The rapids ended in a violent whirlpool. A three-quarter-mile portage ran along the west side (Durbin 1997). These whitewater features are believed to have claimed the lives of hundreds of loggers rafting trees downriver through the late 1800s. Only one of these rapids remains on the entire river, Big Bull Falls, the site of annual canoe and kayak whitewater competitions in Wausau. Dams have inundated the other rapids.

Even though the Wisconsin River has been dammed in many places, the flowing current extends from the tailwaters of some dams to the lake-like, low or no flow conditions of the next impoundment downstream. Three stretches of river still support some rare species (see "Fauna" section below).

Springs

There are 624 documented springs flowing in this ecological landscape (Macholl 2007). This amounts to a density of 0.09 springs per square mile, or one spring for every 11.6 square miles. This is right at the median spring density for all ecological landscapes but is only about half the density of springs per square mile across the entire state. Springs in this ecological landscape tend to be concentrated in northern Clark County and in a band trending from eastern Marathon, through southern Langlade, and into other northern counties to the east.

On the eastern side of this ecological landscape, in southern Langlade and northern Menominee counties, there is a high concentration of "spring ponds" or spring-fed lakes, ranging in size from a few hundred square feet to perhaps 20 acres, all of which have high spring inputs. Spring ponds tend to be found in kettle-like depressions within unconsolidated glacial till that in this area tends to be about 100 feet thick and where the groundwater saturated zone is at least 50 feet thick (Batten 1987). These spring pond outlet flows provide enough cold water to support trout throughout the summer and are important to sustain brook trout populations. Springs supply clean, highly oxygenated, cold water, which is essential for streams that support coldwater species, including trout and associated aquatic insects. Some spring ponds may be subject to shoreline or other degradation due to overuse, overbrowsing of trees such as northern white-cedar (*Thuja occidentalis*) and eastern hemlock and certain understory plants by white-tailed deer (*Odocoileus virginianus*) or past grazing and trampling by livestock. Some springs in the southern portion of this ecological landscape (in northern Portage County) are losing flow due to the impacts of urbanization or municipal and agricultural ***high capacity wells*** drawing down spring recharge areas (Kraft and Mechenich 2010). There is concern that similar impacts could occur in southern Antigo County, an area with a high concentration of springs and the potential for an increase in high capacity irrigation wells. State fishery areas, ***state natural areas***, other protected lands, and areas of intact permanent vegetation, especially forest, often play an important role in protecting the recharge areas of springs, but such protected areas cannot prevent the impacts of operating a large number of high capacity wells (NY CREP 2013).

Wetlands

According to the Wisconsin Wetland Inventory (WDNR 2010b), there are about 686,000 acres of wetlands in the Forest Transition, and over half (387,000 acres) of these are forested. Nonforested wetlands in the ecological landscape include shrub swamp (147,000 acres) and emergent/wet meadow (111,500 acres). The Forest Transition ranks third in the number of wetland acres among Wisconsin's 16 ecological landscapes and eighth in the percentage of wetland cover (15.5%).

Conifer swamp is an abundant wetland type in the northeastern portion of this ecological landscape (portions of Langlade, Lincoln, Menominee, and Shawano counties), while emergent aquatic wetlands are very common in the central part (e.g., in Marathon, Portage, and Wood counties). Wetlands help maintain good water quality and provide habitat for a wide variety of plants and animals, including rare species. The Straight Lake wetlands and the Mead Wildlife Area, both Conservation Opportunity Areas, are among the most significant wetland complexes in the Forest Transition.

Wild rice (*Zizania* spp.) is documented as prevalent in 26 lakes here, making this ecological landscape important to the state's wild rice populations (see the "Inland Lakes" section above). However, wild rice is not found in any rivers or streams here. Wild rice is highly valued as a food plant by many wildlife species, and it is also a dietary staple and is revered as a cultural icon by American Indians. Potential threats to wild rice here and elsewhere in its present Wisconsin range include hydrologic disruption; poor water quality due to excess sediment or nutrient inputs; ill-advised herbicide use; replacement of native genotypes by wild rice strains genetically engineered for commercial cultivation; deliberate introduction of Asian wild rice (*Zizania latifolia*); overharvest of native rice beds; negative impacts of exotic animals such as common carp (*Cyprinus carpio*) and rusty crayfish (*Orconectes rusticus*), which often snip the stems of rice plants; competition from other plants, such as the nonnative invasive European strain (haplotype) of common reed (*Phragmites australis*) and the exotic narrow-leaved cattail (*Typha angustifolia*); and removal by riparian landowners who treat it as an undesirable weed. Where flowing waters harbor wild rice, incompatible water level changes due to dam operations may also pose a threat (GLIFWC 2008).

Water Quality

Water quality varies greatly across this ecological landscape, depending on the type and intensity of major land uses. Watersheds which are mostly forested and have few urban areas tend to have high water quality. Parts of the ecological landscape where agricultural land uses are predominant are characterized by excess nutrient and sediment runoff, exacerbated by high concentrations of dairy farms, streambank pasturing, and an increase in the number of concentrated animal feedlots (these occur especially in Clark, Marathon, and Taylor counties). The proximity of the eastern portion of this ecological landscape (the Wolf River basin) to rapidly developing areas such as Green Bay and the Fox River valley may make it more susceptible to loss of forested habitat. Additional challenges to maintaining healthy aquatic ecosystems include the introduction and spread of exotic species such as purple loosestrife (*Lythrum salicaria*), zebra mussel (*Dreissena polymorpha*), common carp, and others that disrupt surface waters, wetlands, or both.

Wausau is the largest municipality in this ecological landscape, with major municipal and industrial discharges to the Wisconsin River, and there are many small communities that discharge treated wastewater to various other streams. Many streams in this ecological landscape are crossed by roads or other rights-of-way, with bridge and culvert crossings that have the potential to fragment or otherwise adversely impact waterways and aquatic biota if not properly designed, built, and maintained. Approximately 46% of the cover in the Forest Transition is agricultural crops and grassland (pasture, hay, and small grains), which impacts lake and stream water quality unless sound nutrient and soil management practices are implemented.

Outstanding Resource Waters (ORW) or ***Exceptional Resource Waters*** (ERW) are surface waters that have good water quality, support valuable fisheries and wildlife habitat, provide outstanding recreational opportunities, and are not significantly impacted by human activities. Waters with ORW or ERW status warrant additional protection from the effects of pollution. Both designations have regulatory restrictions, with ORWs being the most restricted. These designations are intended to meet federal Clean Water Act obligations and prevent any lowering of water quality or degrading of aquatic habitats in these waters. They are also used to inform and provide guidance for land use changes and human activities near these waters.

There are 18 lakes designated as ORW or ERW in this ecological landscape, including Long Lake, Spring Lake, Amherst Millpond, Ogdensburg Pond, Iola Lake, Graham Lake, North Lake, Archibald Lake, Moose Lake, Chain Lake, Lake John, and Bass Lake (WDNR 2012b). Long Lake and Lake John have documented infestations of Eurasian watermilfoil (*Myriophyllum spicatum*), and all lakes in this ecological landscape are impacted by atmospheric deposition of mercury and are subject to the statewide fish consumption advisory (as is the case with every lake in the state).

There are 253 ORW/ERW streams in this ecological landscape, about 60% of which are small, unnamed creeks (WDNR 2012b). Among these high quality streams are the Waupaca River, South Branch Embarrass River, South Branch Oconto River, Little Wolf River, South Branch Little Wolf River, North Fork Clam River, Saint Croix River, South Branch Pigeon River, Plover River, Big Rib River, West Branch Red River, Little Trappe River, Prairie River, and Emmons Creek. More than half of these streams are designated as Class 1 trout waters, while most of the smaller streams have not been classified. The St. Croix, Red Cedar, New Wood, and South Branch of the Embarrass River are warmwater streams with good to excellent water quality. A complete list of Outstanding and Exceptional Resource Waters in this ecological landscape can be found on the Wisconsin DNR website (WDNR 2012b).

Waters designated as impaired on the ***U.S. Environmental Protection Agency 303(d) list*** exhibit various water quality problems including ***polychlorinated biphenyls*** (PCBs) in fish, sediments contaminated with industrial metals, mercury from atmospheric deposition, bacteria from farm and urban runoff, and habitat degradation. Since the 303(d) designation is narrowly based on the criteria above, a waterbody could be listed as a 303(d) water as well as an ORW or ERW. These designations are not mutually exclusive. A plan is required by the U.S. Environmental Protection Agency on how 303(d) designated waters will be improved by the Wisconsin DNR. This designation is used as the basis for obtaining federal funding, planning aquatic management work, and meeting federal water quality regulations.

Twenty-four ***stream segments*** in the Forest Transition Ecological Landscape were listed as 303(d) impaired waters in 2010 (WDNR 2010a), including Spring Brook, Saint Croix River, Chippewa River, Wolf River, Big Eau Pleine River, Wisconsin River, Big Rib River, Mill Creek, Red Cedar River, Little Hay Creek, Chetek River, Black River, and Spring Brook. Accumulations of PCBs or mercury in sediments and high phosphorus levels are causing these impairments, often in impounded stream sections.

The designation of 33 lakes and reservoirs as 303(d) impaired waters in both urban and rural parts of the Forest Transition Ecological Landscape reflects in most cases the ubiquitous atmospheric deposition of mercury, largely from coal combustion in the U.S. Many of the prominent waters here have elevated mercury levels in sport fish, including Round, Mud Hen, Tenmile, Dunham, and Maiden lakes. The lakes comprising the Chetek Lakes Chain, including Pokegama, Mud, Chetek, and Prairie lakes, are also impaired by excessive phosphorus originating in its heavily agricultural watershed (CLPA 2001). A comprehensive management plan process was begun in 2013 to identify restorative measures for this chain of lakes. Lake Wissota on the Chippewa River just above the city of Chippewa Falls is impaired by PCBs as well as by mercury and phosphorus. The complete list of 303(d) impaired waters and the impairment criteria can be viewed at the Wisconsin DNR's impaired waters web page (WDNR 2010a).

Big Eau Pleine Flowage has high ***biological oxygen demand*** (BOD) and excessive phosphorus caused by agricultural runoff and poor septic systems as well as mercury-contaminated sediments (USDA NRCS 2007). An especially severe fish kill occurred in March, 2009, due to extremely low dissolved oxygen levels, despite oxygen input from an aeration system (W.A. Smith, Wisconsin DNR, personal communication).

The federal Natural Resources Conservation Service assessed the agricultural nonpoint pollution potential for the Lake DuBay Watershed, which is centered on the central Wisconsin River and its tributaries (USDA NRCS 2007). The Central Wisconsin River basin covers about one-third of this entire ecological landscape. The U.S. Department of Agriculture used a model to generate a watershed assessment score relative to other comparable watersheds in Wisconsin. Factors used in the model include acres of cropland, acres of highly erodible land (HEL), and the number of animal units of livestock in the watershed. Scores statewide ranged from 0.0 (lowest contamination potential) to 24.2 (highest contamination potential). The scores may be useful in determining funding allocations on a watershed basis for agricultural nonpoint pollution control initiatives. The model does not attempt to measure pollution levels and does not reflect pollution potential from point sources of pollution or other nonpoint pollution sources beyond the above criteria. Using this model, the watershed assessment score for the Lake DuBay Watershed is 10.8 (a fairly high contamination potential).

The Central Wisconsin River basin portion of the Forest Transition contains several coldwater streams, some of which are in good condition. Others are threatened by urban and agricultural nonpoint source pollution and excessive water withdrawals from municipal and industrial wells (see Appendix 11.A). Stormwater runoff from urban areas, barnyard runoff, and inadequate sod cover on streambanks top the list of problems. An extensive effort to restore in-stream habitat for trout and the purchase of streambank easements for fishing access has been somewhat successful in the Central Wisconsin River basin (WDNR 2001a). Habitat improvements have included vegetated buffers to help improve water quality (Daniels and Gilliam 1996, Wang et al. 1997).

Biotic Environment

Vegetation and Land Cover

Historical Vegetation

Several sources were used to characterize the historical vegetation of the Forest Transition, relying heavily on data from the federal General Land Office's public land survey (PLS), conducted in Wisconsin between 1832 and 1866 (Schulte and Mladenoff 2001). PLS data are useful for providing estimates of forest composition and tree species dominance for large areas (Manies and Mladenoff 2000). Finley's map of historical land cover based on his interpretation of PLS data was also consulted (Finley 1976). Additional inferences about vegetative cover were sometimes drawn from information on land capability, climate, natural disturbance regimes, activities of native peoples, and various descriptive narratives. More information about these data sources is available in Appendix C, "Data Sources Used in the Book," in Part 3, "Supporting Materials."

According to Finley's data interpretation, in the mid-1800s the Forest Transition was dominated by northern hardwood and hemlock-hardwood forests (Finley 1976). In Finley's interpretation, somewhat more than half of the northern hardwood forests included components of eastern hemlock, with the easternmost forests containing occasional inclusions of American beech (*Fagus grandifolia*). No other type (as defined by Finley) occupied more than 8% of the area in this ecological landscape (Figure 11.2). See the map "Vegetation of the Forest Transition in the Mid-1800s" in Appendix 11.K.

Federal public land survey information from the mid-1800s has been converted to a database format and relative importance values for tree species calculated based on the average of tree species density and ***basal area*** (He et al. 2000). Relative importance value (RIV) does not indicate the percentage of land cover of a species or group of species; rather it gives an indication of the importance of an individual species or group of species in a given forested land area. This analysis indicates that sugar maple (16.4% of the RIV), eastern hemlock (15.7% of the RIV), and yellow birch (15.5% of the RIV) had the highest RIVs in the Forest Transition. Eastern white pine was the only other species with an RIV over 10% (11.8%).

Current Vegetation

There are several data sets available to help assess current vegetation on a broad scale in Wisconsin. Each was developed for different purposes and has its own strengths and limitations in describing vegetation. For the most part, WISCLAND (Wisconsin Initiative for Statewide Cooperation on Landscape Analysis and Data), the Wisconsin Wetlands Inventory (WWI), the U.S. Forest Service's Forest Inventory and Analysis (FIA), and the National Land Cover Database (NLCD) were used. Results among these data sets often differ because they are the products of different methodologies for classifying land cover, and each data set was compiled based on sampling or imagery collected in different years, sometimes at different seasons, and at different scales. In general, information was cited from the data set(s) deemed most appropriate for the specific factor being discussed. Information on data source methodologies, strengths, and limitations is provided in Appendix C, "Data Sources Used in the Book," in Part 3, "Supporting Materials."

The Forest Transition Ecological Landscape is approximately 4,656,000 acres, of which approximately 44% was forested in 1992 (WDNR 1993). WISCLAND also indicates that 31% of the ecological landscape was in agriculture and 14% was in grassland (pasture, hay, and small grains), and this ecological landscape had the largest agricultural acreage of all of the ecological landscapes north of the Tension Zone. Forested and nonforested wetlands combined accounted for 13% of the ecological landscape's area (Figure 11.3).

According to the Wisconsin Wetlands Inventory (WDNR 2010b), wetlands in the Forest Transition comprise 16% (approximately 690,000 acres) of this ecological landscape's land cover (as of this writing, there are no data available for Eau Claire or Chippewa counties, so wetlands there are not included in this total). Forested wetlands make up nearly 390,000 acres of the ecological landscape, making these the most abundant wetlands in the Forest Transition. Shrub/scrub wetlands occur on nearly 150,000 acres, and emergent/wet meadow wetlands occupy more than 110,000 acres. Additional information on wetlands and wetland flora may be found in the "Natural Communities" and "Flora" sections below and in Chapter 7, "Natural Communities, Aquatic Features, and Selected Habitats of Wisconsin."

According to FIA data summarized in 2004 (USFS 2004), approximately 42% of the land area in the Forest Transition Ecological Landscape was forested. The predominant forest ***cover type*** group is northern hardwoods (42%) (followed by aspen-birch (19%), and oak-hickory (12%) (Figure 11.4). All other forest types occupy 10% or less of the forested land area.

Changes in Vegetation over Time

The purpose of examining historical conditions is to identify ecosystem factors that formerly sustained species and communities now altered in number, size, or extent or that have been changed functionally (for example, by constructing dams or suppressing fires). Although data are limited to a specific snapshot in time (albeit one that had major significance in its short-term and long-term impacts), they provide valuable insights into Wisconsin's vegetation history, land cover changes, and ecological capabilities. Maintaining or restoring some lands to more closely resemble historical conditions and including some structural or compositional components of the historical landscape within actively managed lands can help conserve important elements of biological diversity. We do not mean to imply that entire ecological landscapes should be restored to historical conditions as this is neither possible nor desirable within the context of providing for current human needs and desires. The following are general trends in vegetation, land cover, and land use change since the early to mid-1800s, based on Finley's land cover data, WISCLAND data, and FIA data.

Information on the methodologies, strengths, and limitations of the vegetation change data is provided in Appendix C, "Data Sources Used in the Book," in Part 3, "Supporting Materials."

The most obvious change in the Forest Transition Ecological Landscape is the dramatic reduction in forest cover from Finley's estimate of 86% at the time of the federal public land survey to roughly 44% in 1992 (WISCLAND) or 42% (FIA)

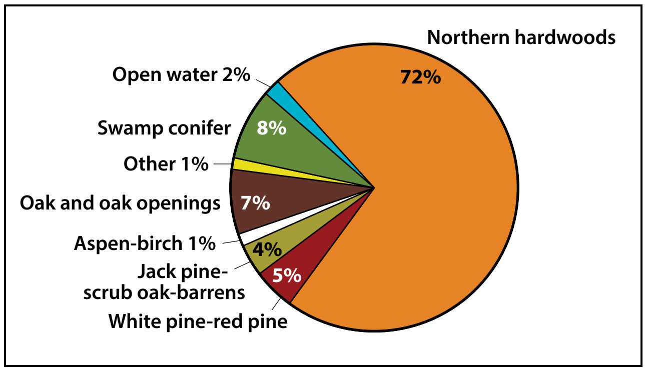


Figure 11.2. *Vegetation of the Forest Transition Ecological Landscape during the mid-1800s as interpreted by Finley (1976) from the federal General Land Office public land survey information.*

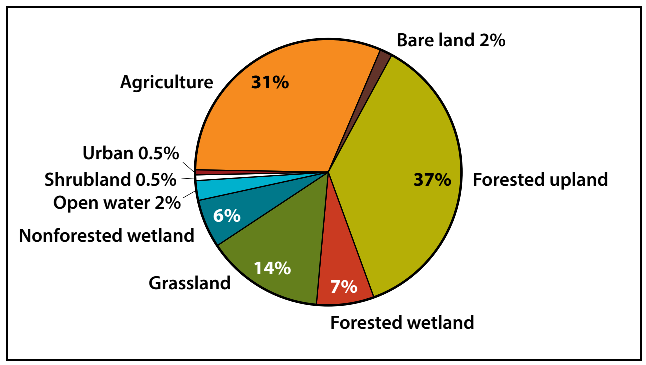


Figure 11.3. *WISCLAND land use/land cover data showing categories of land use classified from 1992 LANDSAT satellite imagery for the Forest Transition Ecological Landscape (WDNR 1993).*

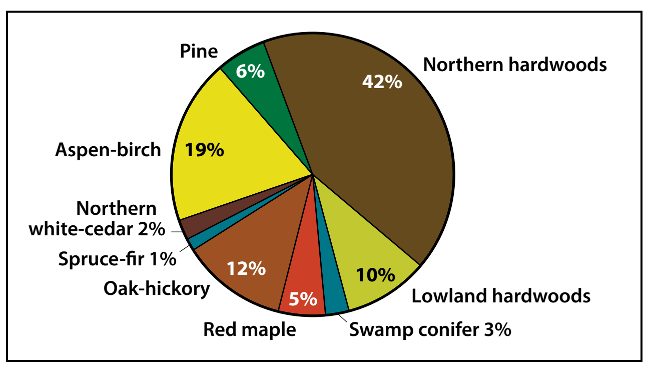


Figure 11.4. *Forest Inventory and Analysis data (USFS 2004) showing forest type as a percentage of forested land area (greater than 17% crown cover) for the Forest Transition Ecological Landscape. See Appendix C, "Data Sources Used in the Book," in Part 3, "Supporting Materials," for more information about the FIA data.*

in 2004 (USFS 2004). This removal of half the forest cover was primarily the result of forest clearing for agricultural use.

In order to explore the changes in composition of tree species in forested areas of the Forest Transition, the relative importance value (RIV) for tree species at the time of the federal public land survey was compared with FIA data summarized in 2004 (Figure 11.5). Here, only FIA data for trees greater than 6 inches in diameter were used to make those data more comparable to the public land survey data. It is also important to remember that RIV does not represent the amount of land covered by a given species or group of species. Rather, it gives an indication of how important (as an average of the percentage of basal area and the percentage of density of forested land area) a given tree species was in the current or past forested land. See Appendix G, "Data Sources Used in the Book," in Part 3, "Supporting Materials," for further discussion of RIV.

Northern hardwood species, as a group, are still dominant in the remaining forested areas of the Forest Transition; they represent over one-third of the ecological landscape, and no other species group has a RIV greater than 20% (Figure 11.5). Although they remain the most prevalent type based on RIV, northern hardwood species have been replaced by other species, most notably red maple (*Acer rubrum*), whose RIV has increased nearly twelvefold since the mid-1880s.

Along with the gross changes in vegetative cover, forest structure and pattern are dramatically different in modern times. ***Old-growth forests***, common historically, are all but absent, and the majority of the mesic forests here exhibit greatly simplified structure and species composition. Forests are also more fragmented, with extensive unbroken forests currently best represented in the eastern portion of the ecological landscape in the Menominee Indian Reservation and Chequamegon-Nicolet National Forest. Moderately sized areas of contiguous forest occur in a few parts of the western end of the ecological landscape, and some of these are especially noteworthy because of the high percentage of oak and, less commonly, eastern white pine that they now support (e.g., Straight Lake State Park and Wildlife Area).

Open (nonforested) land was almost nonexistent historically but is now abundant. Most of this open land is associated with agricultural activities, but at several locations, relatively extensive areas of upland grass (composed mostly of nonnative cool season grasses, not native prairie species) and adjoining or nearby open wetlands are being managed to benefit grassland wildlife, including the area-sensitive Wisconsin Threatened Greater Prairie-Chicken (*Tympanuchus cupido*) (see the "Fauna" section below).

Natural Communities

This section summarizes the abundance and importance of major physiognomic (structural) natural community groups occurring here. Some of the exceptional opportunities, needs, and actions associated with these groups, or with some of the individual natural communities, are discussed briefly. For details on the composition, structure, and distribution of the

The land cover pattern in much of the Forest Transition Ecological Landscape today consists of remnant patches of forest bordered by agricultural fields. Oak forest and agricultural fields, Barron County. Photo by Eric Epstein, Wisconsin DNR.

Depauperate northern hardwood forest with little structure and no conifers. Large trees, snags, ***coarse woody debris****, and other important forest structural features are absent, and the understory is dominated by dense sods of Pennsylvania sedge. Such stands, now common in many parts of northern Wisconsin, have not recovered from the treatment they received during the Cutover of the late 19th and early 20th centuries. Marathon County. Photo by Eric Epstein, Wisconsin DNR.*

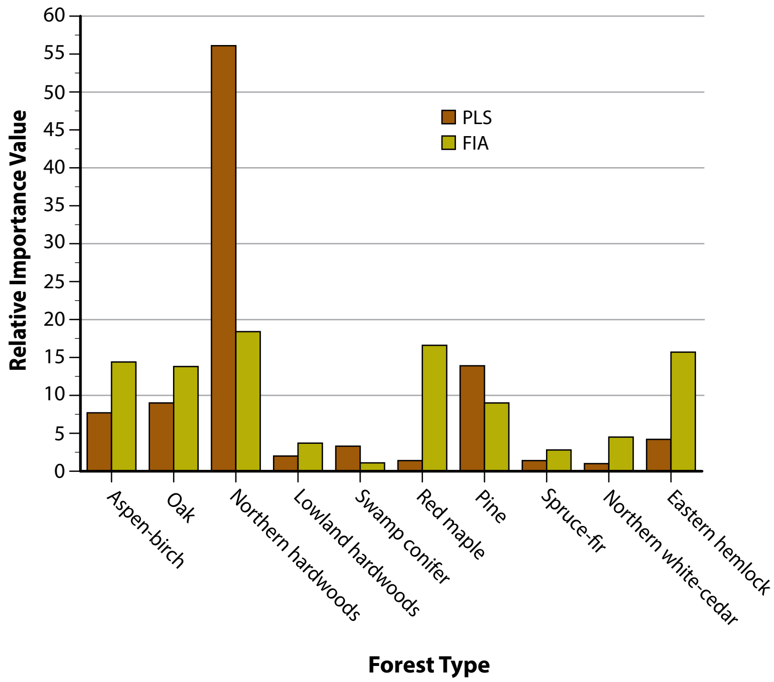


Figure 11.5. *Comparison of tree species' relative importance value (average of relative dominance and relative density) for the Forest Transition Ecological Landscape during the mid-1800s, when federal General Land Office public land survey (PLS) data were collected, with 2004 estimates from Forest Inventory and Analysis (FIA) data (USFS 2004). Each bar represents the proportion of that forest type in the data set (totals equal 100). Trees of less than 6-inch diameter were excluded from the FIA data set to make it more comparable with PLS data. See Appendix C, "Data Sources Used in the Book," in Part 3, "Supporting Materials," for more information about the PLS and FIA data.*

specific natural communities found in the Forest Transition Ecological Landscape, see Chapter 7, "Natural Communities, Aquatic Features, and Selected Habitats of Wisconsin." Information on invasive species can be found in the "Natural and Human Disturbances" section of this chapter.

Forests. The majority of this ecological landscape was historically forested, with Northern Mesic Forest the prevalent community. Within the dominant mesic forest community there was a great deal of variability. American beech reaches its western range limits in the eastern part of the ecological landscape where it is sometimes an important canopy component of forests on the Menominee Indian Reservation, and in northern Oconto County, in Lakewood District of the Chequamegon-Nicolet National Forest. According to Finley's map and data interpretation of conditions prior to Euro-American settlement (Finley 1976), eastern hemlock was a dominant tree along with sugar maple, yellow birch, and American basswood (*Tilia americana*) over much of the ecological landscape but declined in importance and is virtually absent from the Forest Transition west of Chippewa County. Huge eastern white pines occurred as scattered ***supercanopy*** trees or small groves within these mesic forests. Much of this forest was in or approaching old-growth conditions.

Currently, remnant older forests are best represented on the Menominee Indian Reservation. Though this has been a working forest since the mid-19th century, many of the reservation lands were never clearcut and burned. Large trees are still common there, and characteristic species that have declined significantly throughout most of northern Wisconsin, such as eastern hemlock and yellow birch, are still common. Supercanopy eastern white pines are still present in a few areas, albeit on an extremely limited number of acres. Forest composition and structure resembles the pre-Euro-American settlement condition much more closely than on other ownerships, including the adjoining Chequamegon-Nicolet National Forest.

Limited areas of pine-dominated dry-mesic forest occurred on areas of rough, coarse-textured end moraines, in association with bedrock habitats near the St. Croix River. Of special interest is the abundance of oak, including northern red (*Quercus rubra*) and white (*Quercus alba*) oaks, on dry-mesic sites on the St. Croix Moraine in the western part of the Forest Transition.

Canopy dominants of dry-mesic forests in the westernmost part of the Forest Transition may include northern red and white oaks. Older, more extensive stands of this natural community provide important habitat for sensitive birds, especially the Wisconsin Threatened Cerulean Warbler. Polk County, near Osceola. Photo by Eric Epstein, Wisconsin DNR.

Older Northern Mesic Forest of eastern hemlock and American beech bordering coldwater stream. Snow Falls Creek Research Natural Area, Lakewood-Laona District, Chequamegon-Nicolet National Forest, Oconto County. Photo by Eric Epstein, Wisconsin DNR.

Bedrock Glade on basalt, with oaks as the dominant trees. The understory is composed of species associated with xeric prairies and also includes a number of bedrock specialists, some of them quite rare. Interstate Glade, between St. Croix Falls and Osceola, Polk County. Photo by Eric Epstein, Wisconsin DNR.

Lowland conifer-dominated forests composed of black spruce (*Picea mariana*), tamarack (*Larix laricina*), or mixtures of those species are relatively common and characteristic of the more acid peatlands in this ecological landscape. Groundwater-fed wet-mesic forests composed of northern white-cedar, balsam fir (*Abies balsamea*), and black ash (*Fraxinus nigra*) occur here but are less common than the more acid peat forests of black spruce and tamarack. In general, conifer swamps are more common, more extensive, and usually bordered by extensive upland forests in ecological landscapes farther north.

Limited areas of black ash-dominated Northern Hardwood Swamp are present, and Floodplain Forest occurs along some of the major rivers, including the Wisconsin and St. Croix rivers.

Savannas. Savannas were absent from most of the Forest Transition except where the southern and western margins of the ecological landscape bordered fire-adapted vegetation and where there were no physical features that impeded the run of wildfires. Areas in which bedrock is at or very close to the surface may support relatively sparse vegetation that lacks the dense canopies of almost all forests in this ecological landscape. Some of the glades in western Polk County have a savanna-like structure, with a canopy of open-grown oaks of short stature and large, widely spreading limbs.

Few, if any, true savanna remnants have been documented in the Forest Transition Ecological Landscape. There is limited potential for such communities in the western part of the ecological landscape in Polk, Barron, and Chippewa counties and perhaps in areas of rough, coarse-textured moraine that were formerly subject to periodic wildfire.

Finley (1976) mapped small portions of the Forest Transition as "Jack Pine, Scrub Oak, and Barrens," but apparently few remnants of this fire-dependent vegetation have persisted or been identified.

Shrub Communities. Alder Thicket is the prevalent tall shrub community. It is widespread, bordering the edges of streams, lakes, and some open and forested wetlands throughout the ecological landscape. Shrub-carr also occurs here, mostly in the southern portions of the ecological landscape, as an integral part of wetland complexes that may include Southern Sedge Meadow and Emergent Marsh. Here, as in most parts of Wisconsin, upland shrub communities are most often the result of intensive logging, severe blowdown, or, in past years, fire. Today such sites quickly succeed from dominance by shrubs and saplings to forest.

Herbaceous Communities. Herb-dominated natural communities are scarce here. Poor Fen/Open Bog, Northern Sedge Meadow, and Emergent Marsh are the most representative natural communities from this group occurring in the Forest Transition. The extent to which the large dams on the major rivers and streams have altered the abundance of these communities is not well documented or understood, and it would be useful for conservation purposes to have a better grasp of how much marsh and meadow are not now affected by (or the result of) water control structures.

Because more than 50% of the forest that covered virtually all of the Forest Transition prior to Euro-American settlement has been cleared and replaced by cropland, hay, and pasture, open land is common, especially in the central areas (especially in Marathon, northern Wood, northern Clark, and Chippewa counties). Surrogate grasslands are locally common here, and some of these are large enough to support populations of declining grassland birds, including flagship species such as the Greater Prairie-Chicken. The largest open areas occur where extensive surrogate grasslands adjoin open wetlands at sites that include George Mead and Paul Olson State Wildlife Areas.

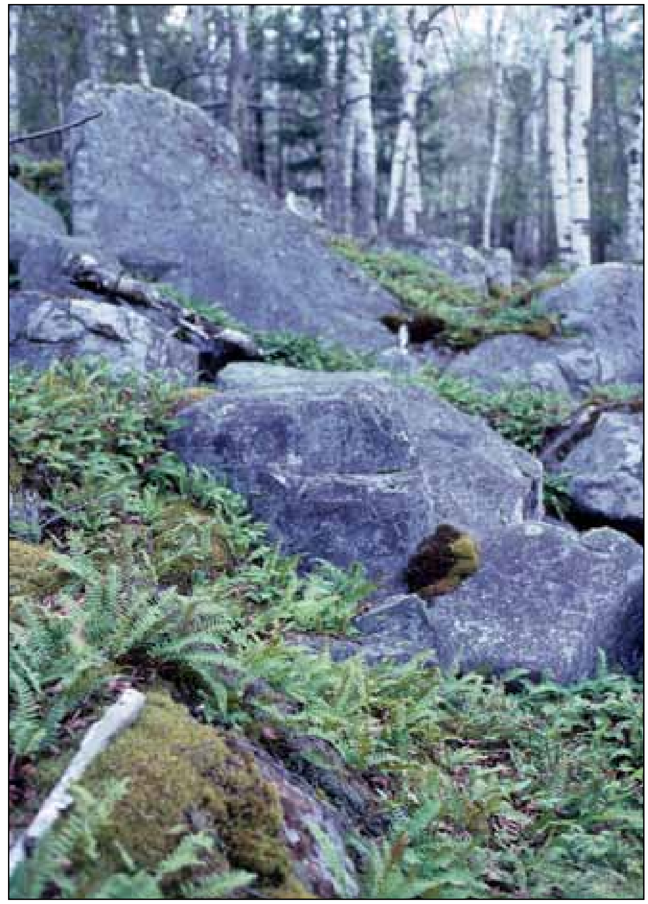
Native grasslands are generally absent from upland sites, with the exception of a few south- or west-facing slopes above the St. Croix River that support prairie vegetation. Such areas

Extensive undisturbed Northern Sedge Meadow in Barron County supports rare plants and animals. Photo by Eric Epstein, Wisconsin DNR.

Past clearing of forests in central Wisconsin has resulted in open areas that provide significant habitat for native grassland wildlife. George W. Mead State Wildlife Area, Marathon-Wood counties. Photo by Wisconsin DNR staff.

tend to be small, isolated, and extremely local. Patches of prairie or prairie-like vegetation have been reported from a few transportation rights-of-way near the southern edge of the Forest Transition, where it is most likely ***adventive*** (Fields 2003).

■ **Bedrock Features.** Bedrock exposures are not particularly common or evenly distributed in the Forest Transition. Bedrock features include cliffs, ***talus slopes***, bedrock glades, and river dalles. Major rock types are granites, basalts, quartzites, and sandstones. Especially noteworthy are the spectacular basalt outcroppings along and near the St. Croix River, metamorphosed rhyolite at the Eau Claire River dalles in Marathon County, the remnant quartzite "mountains" just west of the Wisconsin River between Wausau and Mosinee, and granite and gneiss exposures in and along the Wolf River in Langlade and Menominee counties. The ecological significance of the rock exposures includes their unique physical characteristics, the distinctive assemblages of organisms that inhabit such features, and the habitats such environments provide for highly specialized plants and animals, some of which occur in no other ecological setting.



Quartzite talus, upper north slope of Rib Mountain in Marathon County. Photo by Eric Epstein, Wisconsin DNR.

■ **Aquatic Communities**. See the "Hydrology" section above.

Forest Habitat Types

The Forest Transition is geographically extensive from east to west and diverse in terms of its climate, soil, and vegetation. As a consequence, variability from site to site is potentially high. Four northern habitat type groups are common: mesic to wet-mesic, mesic, dry-mesic, and wet-mesic to wet (Table 11.1). Within these groups, many habitat types occur and may be locally common, but across the broad geographic area encompassed by this ecological landscape, most habitat types are minor to rare. Some southern habitat types also occur, but they are poorly represented at larger scales.

Mesic to wet-mesic sites typically are associated with loamy soils that are somewhat poorly drained and nutrient rich to medium. Hardwood-dominated overstories are common, often composed of some mixture of aspen, red maple, and sugar maple, along with any admixture of white birch (*Betula papyrifera*), yellow birch, American basswood, ashes (*Fraxinus* spp.), elms (*Ulmus* spp.), oaks, balsam fir, or eastern hemlock. Conifer-dominated stands do occur, particularly on nutrient-medium sites and may be dominated by any mix of eastern hemlock, balsam fir, eastern white pine, and, at a few

Table 11.1. *Forest habitat type groups and forest habitat types of the Forest Transition Ecological Landscape (FT EL).*

Northern forest habitat type groups common within the FT EL[b]	Northern forest habitat types[a] common within the FT EL[b]	Nothern forest habitat types minor within the FT EL[b]
Mesic to wet-mesic (M-WM)		TMC ATAtOn ASaI AHI
Mesic (M)	AH	ATM ATDH AHVb ACaCi
Dry-mesic (DM)		AVDe AVb-V AVb AAt
Wet-mesic to wet (WM-W)	Forest Lowland (habitat types not defined)	
Northern forest habitat type groups minor within the FT EL		
Dry to dry-mesic (D-DM)		

Source: Kotar et al. (2002).
[a]Forest habitat types are explained in Appendix 11.B ("Forest Habitat Types in the Forest Transition Ecological Landscape") at the end of this chapter.
[b]Groups listed in order from most to least common:
Common occurrence is an estimated 10–50% of forested land area.
Minor occurrence is an estimated 1–9% of forested land area.
Present – Other habitat types can occur locally, but each represents < 1% of the forested land area of the ecological landscape.

sites, white spruce (*Picea glauca*). Potential late-successional dominants are sugar maple, red maple, and eastern hemlock, accompanied by yellow birch, American basswood, ashes, and balsam fir.

Mesic sites typically are associated with well to moderately well-drained and nutrient-rich to medium loamy soils. Currently, sugar maple is the dominant tree species in many stands, although many other hardwoods and conifers occur, typically as associates. Aspen is another common overstory dominant; however, succession to maple (*Acer* spp.) is well advanced in many stands. Sugar maple and eastern hemlock are potential late-successional dominants, accompanied by yellow birch, American basswood, and white ash (*Fraxinus americana*).

Dry mesic sites typically are associated with sandy loam soils (ranging from loamy sand to silt loam) that are well to moderately well drained and nutrient medium to rich. Common overstory dominants are aspen, red maple, northern red oak, and white oak. Common associates are sugar maple, American basswood, white ash, eastern white pine, and white birch. Potential late-successional dominants are sugar maple, red maple, American basswood, and white ash.

Wet-mesic to wet forested lowlands typically occur on poorly drained peat and muck soils. On nutrient medium to rich sites, stands can be dominated by swamp hardwoods or swamp conifers. On nutrient poor to medium sites, most stands are dominated by swamp conifers.

Flora

Wisconsin DNR's Natural Heritage Inventory program currently tracks 55 vascular plant species for which there are nonhistorical records from the Forest Transition Ecological Landscape (WDNR 2009). Of these 55 species, three are Wisconsin Endangered, nine are Wisconsin Threatened, and 43 are Wisconsin Special Concern. No federally listed species have been documented in this ecological landscape.

Wisconsin Endangered plants documented in this ecological landscape include little goblin moonwort (*Botrychium mormo*), spotted pondweed (*Potamogeton pulcher*), and dwarf huckleberry (*Vaccinium cespitosum*) (WDNR 2009). Little goblin moonwort is considered globally rare (NatureServe 2009) but is represented in the Forest Transition by a single occurrence. Spotted pondweed is also represented here by only one occurrence; however, this is Wisconsin's only nonhistorical population.

Of the nine Wisconsin Threatened plant species documented in the Forest Transition Ecological Landscape, six are represented by single occurrences. Only round-leaved orchis (*Amerorchis rotundifolia*), brittle prickly-pear (*Opuntia fragilis*), and marsh valerian (*Valeriana sitchensis* ssp. *uliginosa*) are represented by multiple populations.

Two of the Wisconsin Threatened plants represented in the Forest Transition by single occurrences are considered to be globally rare: ram's-head lady's-slipper (*Cypripedium arietinum*) and bog bluegrass (*Poa paludigena*).

Based on current knowledge, few rare plant species appear to be highly dependent on Forest Transition populations for their continued existence in Wisconsin at this time. Species that are fairly well represented here compared to other parts of the state include Assiniboine sedge (*Carex assiniboinensis*), white adder's-mouth (*Malaxis monophyllos* var. *brachypoda*), leafy white orchis (*Platanthera dilatata*), Indian cucumber-root (*Medeola virginiana*), and Vasey's pondweed (*Potamogeton vaseyi*). Each of these species is on the Wisconsin Special Concern list (WDNR 2009). Additional details on the rare plants of the Forest Transition Ecological Landscape may be found in Appendix 11.C at the end of this chapter.

In addition to the number of populations occurring in a given ecological landscape, other factors need to be considered when assessing the status of a rare species and its potential conservation priority. These attributes include population size and viability, adequacy of past surveys, taxonomic changes, access to potential habitats, and sufficient knowledge of the species' natural history to enable the design of effective surveys.

Habitats used by rare plants are distributed across this ecological landscape and include most of the major and minor types available. Mesic forests, northern white-cedar swamps, bedrock exposures, and aquatic features supported the highest numbers of rare species. Various wetland communities, especially the acid peatlands, also support rare species. Cliffs and waterfalls provide microhabitats that favor certain plants. Examples include two rare (Wisconsin Special Concern) ferns, fragrant fern (*Dryopteris fragrans* var. *remotiuscula*)

Indian cucumber-root is a native lily strongly associated with mesic maple-beech forests in northeastern Wisconsin. Photo by John Kohout.

The Wisconsin Threatened brittle prickly pear occurs in Bedrock Glade communities along the western edge of the Forest Transition. Photo by Wisconsin DNR staff.

The rare round-leaved orchis (Wisconsin Threatened) inhabits calcareous northen white-cedar swamps in the eastern part of this ecological landscape. Photo by Thomas Meyer, Wisconsin DNR.

and Oregon cliff fern (*Woodsia oregana* var. *cathcartiana*), that occur at Interstate State Park on the rocky ledges above the St. Croix River.

Several northern forest dominants reach their western range limits within this ecological landscape. For example, American beech is not found west of Menominee County, and within the Forest Transition, eastern hemlock drops out in Chippewa County and does not occur at all in the westernmost parts of the ecological landscape.

Past botanical surveys have been spotty here and have often coincided with the distribution and abundance of public lands and the development of management plans for those properties. Relatively well-surveyed areas include the Chequamegon-Nicolet National Forest; the St. Croix National Scenic Riverway; most of the state natural areas; some of the state parks, state wildlife areas, and state fishery areas; and some sites of interest to NGOs needing to better document the botanical values and conditions of sites in which they have potential conservation interest. Detailed and comprehensive plant surveys have seldom been conducted on county forests, and the logistics of conducting botanical surveys over large areas mostly composed of small or moderately scaled, privately owned parcels have been daunting.

Surveys should be directed at areas and habitats known to have the potential for supporting rare or otherwise significant flora. Existing data may be sufficient to identify priority survey sites, habitats, and species. Examples of habitats with potential to yield new records of rare plants include bedrock exposures, rich mesic hardwood forests, dry-mesic forests of oak or oak and pine (*Pinus* spp.) in the western part of the ecological landscape, and hydrologically intact wetlands and aquatic features.

Fauna

Changes in Wildlife over Time

Many wildlife populations have changed dramatically since humans arrived on the landscape, but these changes were not well documented before the mid-1800s. This section discusses only those wildlife species documented in the Forest Transition Ecological Landscape. Of those, this review is limited to species that were known or thought to be especially important here in comparison to other ecological landscapes.

Significant Flora in the Forest Transition Ecological Landscape

- As of 2009, 55 rare plant species have been documented in the Forest Transition over the past 40 years.
- Based on the number of populations documented in the Forest Transition and/or the number of populations elsewhere in the state, there are especially important conservation opportunities for spotted pondweed, slender bulrush, white adder's-mouth, and Indian cucumber-root.
- Important habitats for rare plants include northern mesic forest, northern white-cedar swamps, bedrock features, peatlands, and lakes.
- Relatively uncommon habitats of disproportionate significance to rare plants include northern white-cedar swamps, bedrock features, and open peatlands.
- Mesic forests with rich productive soils have the potential to support diverse assemblages of native plants.
- The matrix mesic forest community exhibits considerable compositional and structural variability because the ranges of several of the dominant trees do not cover the entire ecological landscape.
- Additional botanical surveys are needed in some parts of the Forest Transition, including the central and western areas.
- Given the high degree of disturbance and fragmentation in this ecological landscape, corridors need to be designed that will facilitate the future movements of species.

*Rich mesic hardwood forests may support diverse assemblages of spring wildflowers. Plants pictured here include wild leek (*Allium tricoccum*), cut-leaved toothwort (*Cardamine concatenata*), Virginia waterleaf (*Hydrophyllum virginianum*), large-flowered bellwort (*Uvularia grandiflora*), spring-beauty (*Claytonia virginica*), and dwarf ginseng (*Panex trifolius*). Photo by Drew Feldkirchner, Wisconsin DNR.*

For a more complete review of historical wildlife in the state, see *Wildlife in Early Wisconsin: A Collection of Works by A.W. Schorger* (Brockman and Dow 1982).

The Forest Transition Ecological Landscape was important historically for many wildlife species, especially forest birds and large, wide-ranging forest mammals. This ecological landscape was particularly important for American black bear (*Ursus americanus*), gray wolf (*Canis lupus*), fisher (*Martes pennanti*), American beaver (*Castor canandensis*), North American river otter (*Lontra canadensis*), Passenger Pigeon (*Ectopistes migratorius*), and Sharp-tailed Grouse (*Tympanuchus phasianellus*). Neotropical migrant birds and forest raptors were likely important in this formerly heavily forested ecological landscape, as were the Bald Eagle (*Haliaeetus leucocephalus*), Osprey (*Pandion haliaetus*), and Common Loon (*Gavia immer*) (see Chapter 14, "Northern Highland Ecological Landscape," for a historical description of the latter three species). As forests were logged in the late 19th and early 20th centuries and the ecological landscape was inhabited by Euro-American settlers, wildlife populations changed. Today this ecological landscape is important for white-tailed deer, American black bear, gray wolf, fisher, American beaver, North American river otter, Greater Prairie Chicken, Wild Turkey (*Meleagris gallopavo*), and other forest, grassland, and wetland wildlife.

Historically, the gray wolf was found throughout the state (Schorger 1942a). After the southern part of the state was settled and bounties were imposed, by the 1920s gray wolf populations only remained in the more remote portions of northern Wisconsin (Thiel 1993). Gray wolf populations continued to decline in northern Wisconsin until 1958 when the last Wisconsin gray wolf was thought to have been killed by a car in Bayfield County. By the early 1960s, gray wolves were thought to be extirpated from the state. Occasional sightings of gray wolves occurred throughout the 1960s and 70s, but these were thought to be lone gray wolves wandering from Minnesota or Michigan. Not until the late 1970s was it determined that gray wolves had again become established and were breeding in Wisconsin. In 2006–07, four wolf packs with 13 individuals were found in this ecological landscape. By 2013 the Wisconsin gray wolf population had increased to over 800 individuals. Although this ecological landscape is not very important today as breeding habitat, it is important as a travel and dispersal corridor for maintaining the genetic diversity of gray wolves in central Wisconsin.

Like the gray wolf, cougars (*Puma concolor*) were once found throughout the state but after southern Wisconsin was settled, cougars were only found in the north. The last wild Wisconsin cougar was killed near Butternut, in Ashland County in 1884 (Schorger 1942a). Sporadic cougar sightings occur today, and most of these animals are thought to be dispersing from South Dakota's Black Hills.

American black bears were historically abundant throughout the northern and central parts of the state (Schorger 1947). American black bears remained resident in the northern part of Wisconsin throughout the Euro-American settlement period but in reduced numbers. Today the northern part of this ecological landscape is considered primary range for American black bears while the southern part is regarded as secondary range (Figure 11.6). The Bear Bait Station Survey suggests a marked increase in the American black bear population during the late 1990s and early 2000s here and in central and southern Wisconsin; three-year average visitation rates increased from 17% to 35% during 1996–2004 (Rolley et al. 2013). Bait station visitation rates suggest the American black bear population has been stable to slowly increasing in the last few years in this region of the state.

The fisher and American marten had similar ranges, but the fisher occurred farther south in Wisconsin. The fisher was not as numerous as the American marten and was more common in hardwood forests (Schorger 1942a). There are records of the fisher as far south as La Crosse, Milwaukee, Jefferson, and Sauk counties. In both La Crosse and Sauk counties, it was described as being numerous. Extensive logging, wildfires, and unregulated trapping drastically reduced the fisher population by the early 1900s (Kohn et al. 1993). The fisher was given legal protection in 1921, but the population continued to decline. Only three fishers were trapped during the 1920–21 trapping season. The last verified report of a wild fisher was in 1932. For a detailed account of fisher stocking in Wisconsin, see Williams et al. (2007). Today the fisher occupies almost all suitable habitat in the state, including the Forest Transition Ecological Landscape. In 2012 the statewide population was estimated at over 6,500 animals.

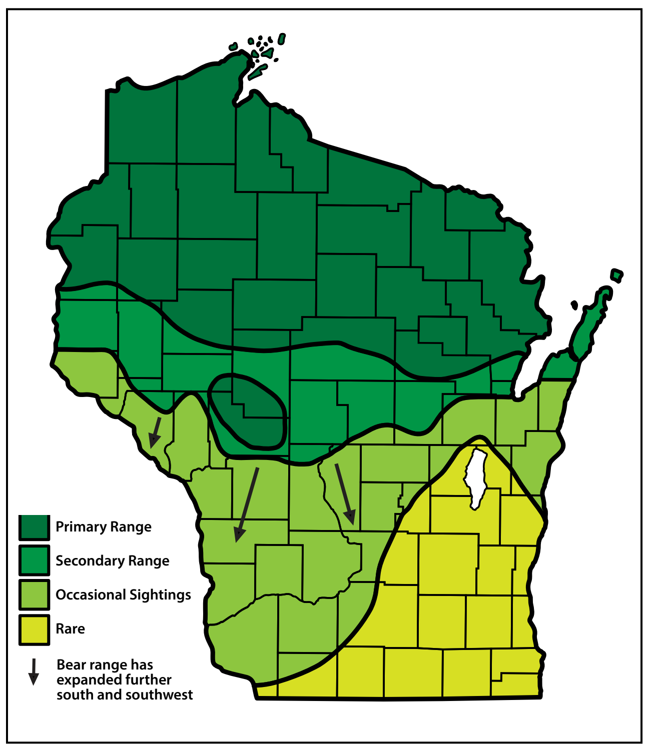


Figure 11.6. *Wisconsin American black bear range.*

Historically the American beaver was present throughout Wisconsin, including the Forest Transition. As elsewhere in the state, American beaver populations declined dramatically with unregulated trapping and hunting for the fur trade through the 1700s and mid-1800s (Schorger 1965). American beaver populations have recovered, and this is now an important species in parts of this ecological landscape because of the many lakes and streams and the abundance of aspen and other preferred foods.

The North American river otter was historically as abundant, or more abundant, than the American beaver across the state (Schorger 1970), based on trapping records. Similar to what happened to the beaver, North American river otter populations declined dramatically throughout the state with unregulated trapping for the fur trade. Today North American river otter populations have recovered, and the species is found throughout this ecological landscape.

White-tailed deer were found throughout the state and were likely more abundant in southern Wisconsin than in the northern part of the state at the time of Euro-American settlement (Schorger 1953). Northern Wisconsin was vegetated primarily with mature coniferous-deciduous forest, not optimal deer habitat, which limited the white-tailed deer population there. The white-tailed deer population expanded in northern Wisconsin after large-scale logging (the ***Cutover***) took place in the late 1800s (Schorger 1953). After cutting, often followed by intense fires, the mature mixed conifer-hardwood forest in northern Wisconsin was replaced by young hardwoods, including vast acreages of aspen and white birch and other forage plants that provided an abundant food supply for white-tailed deer. However, the large number of Euro-American settlers that followed logging depended heavily on venison for food. Subsistence harvest, together with market hunting, likely reduced the state's white-tailed deer population to its lowest level around the turn of the century (1900). Hunting regulations were initiated in 1897, but it was not until the 1920s that overharvesting the white-tailed deer herd was curbed. Conservative harvests in the early 1900s along with regrowth of the northern forest permitted white-tailed deer populations to increase in the north. As white-tailed deer populations grew, the impacts of browsing on forest vegetation became apparent. Starvation of white-tailed deer was first reported in 1930. From 1934 to 1954, large-scale feeding of hay, grain, and concentrate (pellets) was done by Wisconsin Conservation Department wardens in an effort to prevent starvation. Failure of this feeding program prompted attempts to institute antlerless white-tailed deer harvests to control and reduce the white-tailed deer herd. After much public resistance to shooting female white-tailed deer, white-tailed deer management programs were put in place setting white-tailed deer population goals for deer management units within the state and using antlerless white-tailed deer harvest to keep the white-tailed deer at the established goal.

Today white-tailed deer populations in the Forest Transition are large compared to what they were before Euro-American settlement. The mix of agricultural fields and woodlots provide abundant food for white-tailed deer. Relatively mild winters during the decades of the 1990s and 2000s have prevented winter starvation and allowed the white-tailed deer herd to increase (Figure 11.7). The white-tailed deer herd has often been above goal for the Forest Transition Ecological Landscape (Figure 11.8), and agricultural crop damage, car-deer collisions, and overbrowsing of more palatable plants has become common in this ecological landscape.

Although the distribution of the Passenger Pigeon has been described as covering the eastern half of North America, its nesting was limited by the presence and abundance of mast (primarily American beech nuts and acorns). Schorger (1946) reported from 19th century newspaper accounts and interviews that Passenger Pigeons nested by the millions in Wisconsin. With presence of oak in the west and American beech in the east, this ecological landscape was undoubtedly a nesting area for Passenger Pigeons during years of high mast production. A nesting 4 miles long occurred near Shawano in 1872. One of the largest recorded nesting attempts of the Passenger Pigeon occurred in 1878 near Petrosky, Michigan across Lake Michigan at the about the same latitude as this ecological landscape (Schorger 1939).

Passenger Pigeons were shot and trapped during the nesting season and squabs taken from nests and shipped to markets in Milwaukee, Chicago, and cities on the east coast by the trainload (Schorger 1939). Since the Passenger Pigeon was thought to only lay one egg each year, only nested in communal roosts, and was dependent on abundant mast for reproductive success, the heavy kill of the Passenger Pigeon led to its extinction. The last known living Passenger Pigeon died in 1914 at the Cincinnati Zoo.

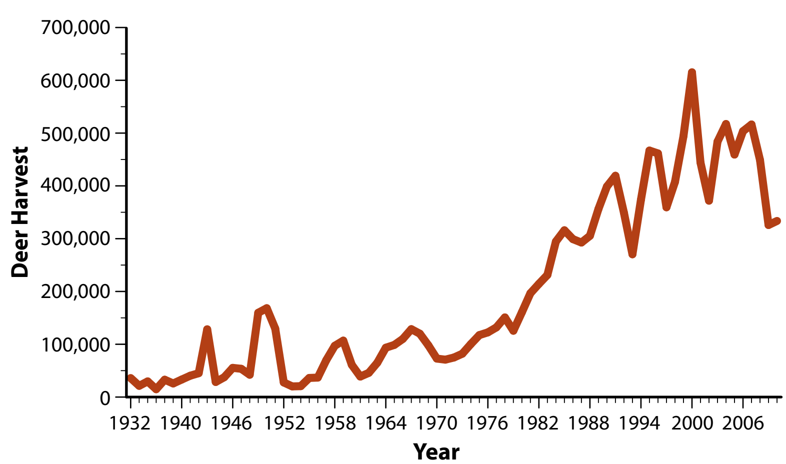


Figure 11.7. *Statewide white-tailed deer harvest, 1932–2010 (Wisconsin DNR unpublished data).*

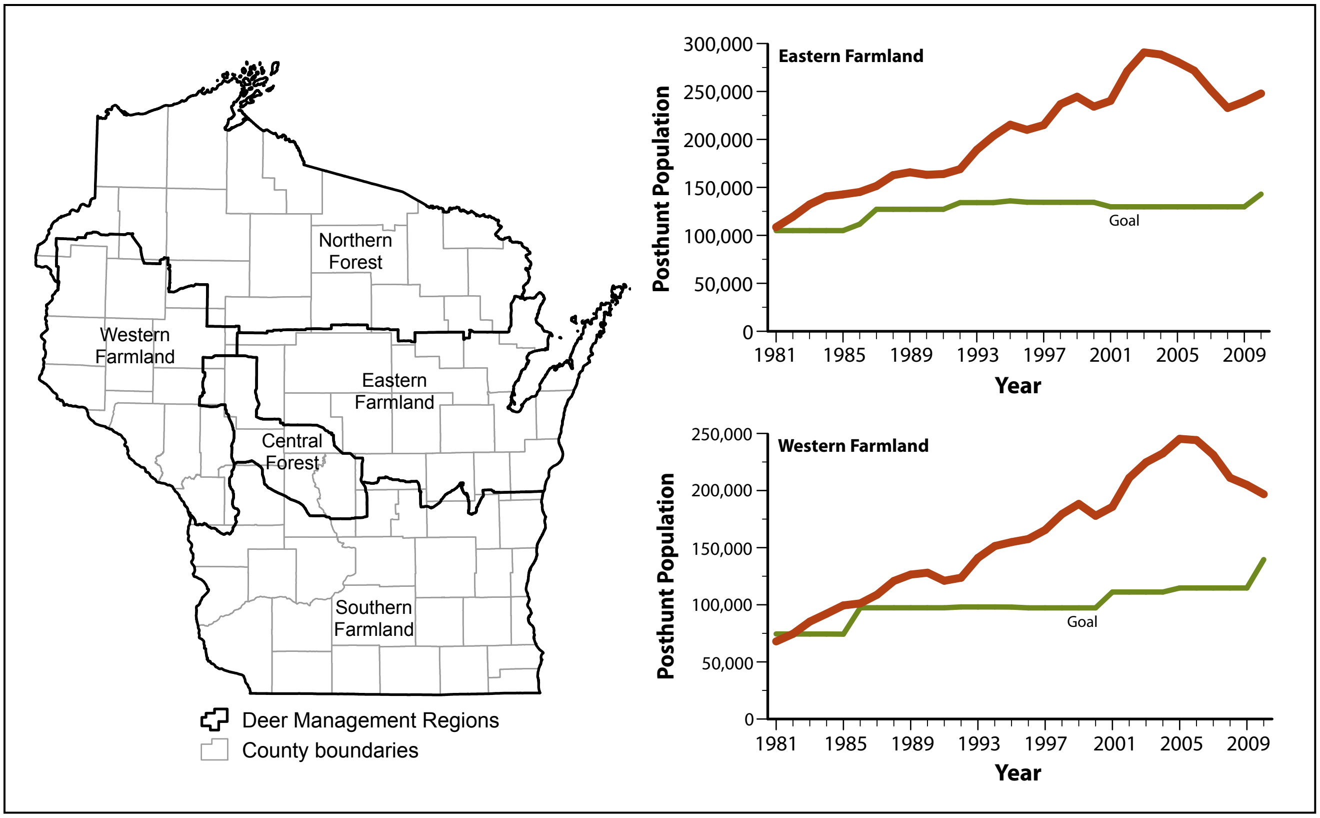


Figure 11.8. *White-tailed deer population size in relation to population goals in the eastern and western farmland deer management regions,1981–2010 (Wisconsin DNR unpublished data).*

The Sharp-tailed Grouse was considered widely distributed in the state in open and brushy habitats prior to Euro-American settlement (Schorger 1943). Sharp-tailed Grouse expanded into some areas they had not previously inhabited during and shortly after the Cutover. Populations later declined as a result of reforestation and/or the expansion of intensive agriculture. In addition, wildfires were suppressed, and as a consequence, suitable natural habitats such as barrens and oak openings (neither of these was common in the Forest Transition) grew up into dense forests, causing populations of Sharp-tailed Grouse to decline further.

There is little historical documentation of the Sharp-tailed Grouse throughout this ecological landscape; however, Schoenebeck (1902) said it was a common resident in Oconto County (more likely in the Northeast Sands Ecological Landscape, to the east of the Forest Transition). As forests were cleared and replaced with brush and saplings, Sharp-tailed Grouse likely spread into parts of the Forest Transition where they did not formerly occur. Gregg and Niemuth (2000) showed that the Sharp-tailed Grouse was present in this ecological landscape in the 1930s to 1950s, with a remnant population until 1975 (Figure 11.9). Today the Sharp-tailed Grouse is gone from this ecological landscape.

The Greater Prairie-Chicken was found throughout southern Wisconsin before Euro-American settlement, although the Sharp-tailed Grouse may have been more abundant (Schorger 1943). The Greater Prairie-Chicken was considered abundant through the 1850s in southern Wisconsin but then declined. At first, agricultural development seemed to allow Greater Prairie-Chicken populations to increase. But as agriculture became more widespread and intensive, populations declined. The result was that the range of the Greater Prairie-Chicken was forced north as prairies were plowed for agriculture in the south while forests were cleared in central and northern Wisconsin. Due to extensive, permanent clearing of forests and conversion to agriculture, the central part of the Forest Transition Ecological Landscape became suitable for the Greater Prairie-Chicken. Today the Greater Prairie-Chicken occurs in Wisconsin only in the Central Sand Plains and Forest Transition ecological landscapes. During 2010–2014, an average of 270 (230–295) Greater Prairie-Chicken males were counted each year on booming grounds in central Wisconsin. These male Greater Prairie-Chickens were counted on the Buena Vista, Paul J. Olson, George W. Mead, and Leola Wildlife Areas. Only two males were seen on outlying private lands within the Forest Transition Ecological Landscape in 2011 (Kardash 2014). The remnant population of Greater Prairie-Chickens on private lands has declined dramatically due to the continuing loss of remaining grassland habitat.

The historical range of the Wild Turkey was in southern Wisconsin below a line from Green Bay to Prairie du Chien

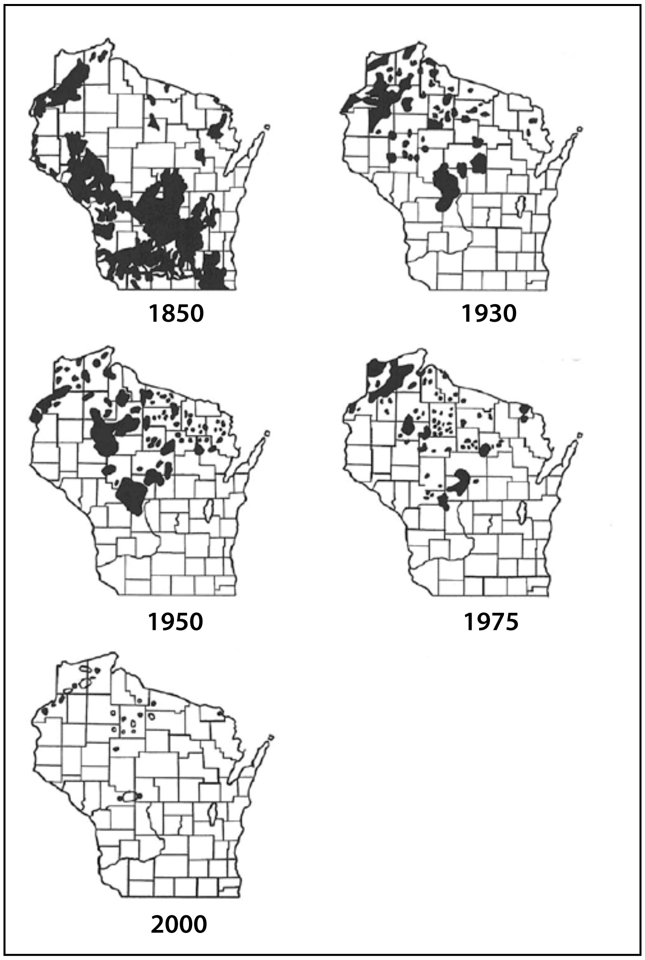


Figure 11.9. *Changes in Sharp-tailed Grouse range since Euro-American settlement. Figure reproduced from Gregg and Niemuth (2000) with permission of the Wisconsin Society for Ornithology.*

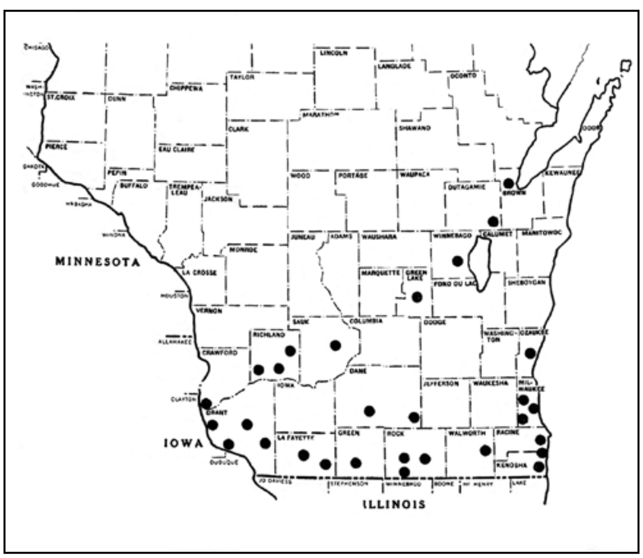


Figure 11.10. *Historical Wild Turkey range in Wisconsin. Figure printed with the written permission of the Wilson Ornithological Society, from Schorger, A.W. 1942. The Wild Turkey in early Wisconsin.* Wilson Bulletin *54:173–182.*

(Figure 11.10; Schorger 1942b). Since the Wild Turkey was at the northernmost edge of its range, the number of turkeys close to this line fluctuated in response to severe winters. Due to persistent hunting by settlers for food, changes to habitats, and the severe winter of 1842–43, Wild Turkeys were rare by 1860. The last documented Wisconsin Wild Turkey was seen in Lafayette County in 1881. Wild Turkeys were not present in the Forest Transition Ecological Landscape before Euro-American settlement.

Wild Turkeys were successfully reintroduced into Wisconsin in 1976. Once established, the Wisconsin DNR trapped and relocated Wild Turkeys throughout the state (Brown and Vander Zouwen 1993). The Wild Turkey is now established in all 16 ecological landscapes, including the Forest Transition Ecological Landscape. In 2012 over 40,000 male turkeys were harvested in the state during the spring Wild Turkey hunting season, including many in the Forest Transition Ecological Landscape (Dhuey et al. 2012).

Significant Wildlife

Wildlife are considered significant for an ecological landscape if (1) the ecological landscape is considered important for maintaining the species in the state and/or (2) the species provides important recreational, social, and economic benefits to the state. To ensure that all native species are maintained in the state, "significant wildlife" includes both common species and species that are considered "rare" (in this book "rare" includes species listed as endangered or threatened by either Wisconsin or the federal government or species that are listed as special concern by the State of Wisconsin). Four categories of species are discussed: rare species, Species of Greatest Conservation Need (SGCN), responsibility species, and socially important species (see definitions in text box). Because the conservation and maintenance of wildlife communities (e.g., grassland birds) and habitats are the most efficient and cost effective way to manage and benefit a majority of species, we discuss management of different wildlife habitats in which significant fauna occur. See Appendix 11.C for a comprehensive list of the rare animals known to exist in the Forest Transition Ecological Landscape. (Note that both the Wisconsin Natural Heritage Working List and the statutory lists of endangered, threatened, and special Concern species are working documents that change periodically.)

■ **Rare Species.** As of November 2009, the Wisconsin Natural Heritage Inventory database contained documented records for 95 rare animal species, including 6 mammals, 20 birds, 6 herptiles, 19 fishes, and 44 invertebrates within the Forest Transition Ecological Landscape (WDNR 2009). These include four U.S. Endangered species, one federal candidate for future listing, 16 Wisconsin Endangered species, 22 Wisconsin Threatened species, and 57 Wisconsin Special Concern species. See Appendix 11.D for the number of species per taxa with special designations documented within the Forest Transition Ecological Landscape.

■ ***Federally Listed Species:***[1] Two mussels are listed as U.S. Endangered in this ecological landscape: winged mapleleaf (*Quadrula fragosa*) and Higgins' eye (*Lampsilis higginsii*). The Karner blue butterfly (*Lycaeides melissa samuelis*) is U.S. Endangered and occurs in the Forest Transition. It is now managed under a Habitat Conservation Plan approved by the U.S. Fish and Wildlife Service in 1999 and revised in 2009. The gray wolf occurs here and was removed from the federal endangered species list in January 2012, granting management authority to the State of Wisconsin. The Wisconsin state legislature passed a law in April 2012 authorizing hunting and trapping seasons for wolves and directed that wolf hunting and trapping seasons be held starting in the fall of 2012. The first hunting and trapping seasons of wolves were therefore conducted during October–December 2012. Wolves are now being managed under a 1999 wolf management plan with addenda in 2006 and 2007, but the plan is being updated to reflect these recent changes in wolf management in Wisconsin. The Bald Eagle, formerly U.S. Threatened, was delisted in 2007 but continues to receive protection under the federal Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act. The Bald Eagle is now listed as a Wisconsin species of special concern.

■ ***Wisconsin Endangered Species:*** In 2009 there were four Wisconsin Endangered birds known from the Forest Transition: the Peregrine Falcon (*Falco peregrinus*), Loggerhead Shrike (*Lanius ludovicianus*), Red-necked Grebe (*Podiceps grisegena*), and Barn Owl (*Tyto alba*); one herptile: northern cricket frog (*Acris crepitans*); two fish: crystal darter (*Crystallaria asprella*) and black redhorse (*Moxostoma duquesnei*); seven mussels: spectacle case, purple wartyback (*Cyclonaias tuberculata*), butterfly (*Ellipsaria lineolata*), elephant ear (*Elliptio crassidens*), snuffbox, Higgins' eye, and winged mapleleaf; and two other invertebrates: northern blue butterfly (*Lycaeides idas*) and Saint Croix snaketail (*Ophiogomphus susbehcha*) (WDNR 2009).

■ ***Wisconsin Threatened Species:*** Wisconsin Threatened species documented in the Forest Transition include five birds: Henslow's Sparrow (*Ammodramus henslowii*), Red-shouldered Hawk (*Buteo lineatus*), Yellow Rail (*Coturnicops noveboracensis*), Cerulean Warbler (*Setophaga cerulea,* listed as *Dendroicia cerulea* on the Wisconsin Natural Heritage Working List), and Greater Prairie-Chicken); two herptiles: wood turtle (*Glyptemys insculpta*) and Blanding's turtle (*Emydoidea blandingii*); and eight fish: blue sucker (*Cycleptus elongatus*), black buffalo (*Ictiobus niger*), redfin shiner (*Lythrurus umbratilis*), river redhorse (*Moxostoma carinatum*), greater redhorse (*Moxostoma valenciennesi*), pugnose shiner (*Notropis anogenus*), Ozark minnow (*Notropis nubilus*), and gilt darter (*Percina evides*). The black buffalo no longer occurs here (J. Lyons, Wisconsin DNR, personal communication). Recent surveys have documented another Wisconsin Threatened fish in the Forest Transition, the crystal darter. These records had not yet been added to the Natural Heritage Inventory database in 2009 so they are not reflected in the number of Wisconsin Threatened fish in this ecological landscape. Other Wisconsin Threatened species documented here are six mussels: slippershell (*Alasmidonta viridis*), monkeyface (*Quadrula metanevra*), wartyback (*Quadrula nodulata*), salamander mussel (*Simpsonaias ambigua*), buckhorn (*Tritogonia verrucosa*), and ellipse (*Venustaconcha ellipsiformis*; and one dragonfly, the pygmy snaketail (*Ophiogomphus howei*) (WDNR 2009).

■ ***Wisconsin Special Concern Species:*** Wisconsin Special Concern species in the Forest Transition include 6 mammals, 11 birds, 3 herptiles, 9 fishes, and 28 invertebrates (WNDR 2009; see Appendix 11.C for a complete rare species list).

The spectacle case is one of four U.S. Endangered mussels (as of 2012) occurring in the lower St. Croix River. Photo by Tamara Smith, U.S. Fish and Wildlife Service.

Pygmy snaketail (Wisconsin Threatened) is a globally rare dragonfly species. Male (bottom); female (top). Photo by W.A. Smith, Wisconsin DNR.

[1]When this material was written, it was based on the 2009 Wisconsin Natural Heritage Working List (WDNR 2009). In 2012 snuffbox (*Epioblasma triquetra*) and spectacle case (*Cumberlandia monodonta*) mussels were listed as U.S. Endangered. Northern long-eared bat (*Myotis septentrionalis*) was listed as U.S. Threatened in 2015.

Categories of Significant Wildlife

- **Rare species** are those that appear on the Wisconsin Natural Heritage Inventory Working List as Wisconsin or U.S. Endangered, Threatened, or Special Concern.
- **Species of Greatest Conservation Need (SGCN)** are described and listed in the Wisconsin Wildlife Action Plan (WDNR 2005b) as those native wildlife species that have low or declining populations, are "indicative of the diversity and health of wildlife" of the state, and need proactive attention in order to avoid additional formal protection.
- **Responsibility species** are both common and rare species whose populations are dependent on Wisconsin for their continued existence (e.g., a relatively high percentage of the global population occurs in Wisconsin). For such a species to be included in a particular ecological landscape, a relatively high percentage of the state population needs to occur there, or good opportunities for effective population protection and habitat management for that species occur in the ecological landscape. Also included here are species for which an ecological landscape holds the state's largest populations, which may be critical for that species' continued existence in Wisconsin even though Wisconsin may not be important for its global survival.
- **Socially important species** are those that provide important recreational, social, or economic benefits to the state for activities such as fishing, hunting, trapping, and wildlife watching.

Species of Greatest Conservation Need. Species of Greatest Conservation Need (SGCN) are those that appear in the Wisconsin Wildlife Action Plan (WDNR 2005b). SGCN include species already recognized as endangered, threatened, or special concern on the Wisconsin or federal lists and include species that are declining. There are 10 mammals, 47 birds, 5 herptiles, and 4 fish listed as SGCN for the Forest Transition Ecological Landscape (see Appendix 11.E for a complete list of Species of Greatest Conservation Need in this ecological landscape and the habitats with which they are associated).

Responsibility Species. The Greater Prairie-Chicken now occurs only in this and one other ecological landscape, the Central Sand Plains just to the south. Currently, over 90% of the Greater Prairie-Chickens in the state are found on managed wildlife areas (Buena Vista/Leola Grasslands in the Central Sand Plains and Paul J. Olson and George W. Mead Wildlife Areas in the Forest Transition Ecological Landscape) that contain large areas of grassland habitat managed specifically for the Prairie Chicken (Warnke 2004). A small number of Greater Prairie-Chickens existed in western Marathon and eastern Clark counties on private lands; however, this population is all but gone (Kardash 2014).

The Greater Prairie-Chicken requires large, open grassland landscapes (Schroeder and Robb 1993). The number of males at a ***lek*** within the Forest Transition Ecological Landscape correlated positively with the amount of grassland cover at multiple spatial scales surrounding the lek (Niemuth 2000). The Greater Prairie-Chicken has complex habitat requirements due to differing life history needs throughout the year. Large patches of taller grass with a well-developed litter layer are required for nesting and roosting cover. However, insect-rich grasslands, pastures, and crop fields are needed for feeding, and short-grass fields are used for lek sites. Managing for the Greater Prairie-Chicken will require having all of these habitats available within one mile of the lek site. Greater Prairie-Chicken management areas should consist of the following landscape components (Hamerstrom et al. 1957, Sample and Mossman 1997): (1) a large area (10,000 to 50,000 acres) of open landscape not more than 20% wooded with wooded tracts in small, scattered blocks and a limited number of linear tree lines; (2) a core of permanent managed grassland at least 2,000 acres in size for every 10,000 acres of Greater Prairie-Chicken range; (3) a minimum of 30% of the open lands in permanent grass cover, including the core and scattered blocks of grassland at least 80 acres or larger in size; (4) scattered blocks of long-term grass cover (e.g., Conservation Reserve Program [CRP] land, Conservation Reserve Enhancement Program [CREP] land, and pasture) totaling an additional 15–20% of the open landscape; and (5) an adequate winter food supply. Connection of open habitats between the Forest Transition and the Central Sand Plains ecological landscapes is important to maintain adequate grassland habitat to sustain the Greater Prairie-Chicken population.

Gray wolves are found along the northern fringe of the Forest Transition Ecological Landscape, with a few pack territories occurring in this ecological landscape and dispersing gray wolves occasionally reported. This ecological landscape is primarily in wolf management Zone 3 according to the Wisconsin Wolf Management Plan (WDNR 1999) and is not considered prime wolf habitat. Zone 3 represents areas having very limited habitat for packs to colonize but probably contains patches of suitable dispersal habitat that connects the north and central management zones. Because of the importance of maintaining genetic diversity in the Central Forest wolf population, allowing wolves to disperse through this area is necessary.

The Wisconsin Endangered crystal darter occurs in relatively good numbers in the St. Croix River below St. Croix Falls. This reach of the St. Croix is one of the state strongholds for this species, along with the lower Chippewa, the lower Red Cedar, and the lower Wisconsin rivers in other ecological landscapes.

The black redhorse is a Wisconsin Endangered fish species found in the Wisconsin and Eau Claire rivers near Wausau in the Forest Transition Ecological Landscape. This species was previously known from only two specimens collected in the Root River and Black Earth Creek, both in southern Wisconsin. It was believed to be extirpated in Wisconsin since the last specimen was collected in 1928. However, this species was rediscovered in 1992 in the Wisconsin River at Wausau. The black redhorse usually lives in moderately sized rivers and streams with generally moderate to fast currents. Substrates include rubble, gravel, sand, boulders, and silt. In summer, they generally prefer pools, and in winter they move to even deeper pools. In the spring, the black redhorse migrates to spawning habitats and use a variety of substrates from fine gravel to large cobbles.

The core distribution of the redside dace (*Clinostomus elongatus*) is centered in and around the Forest Transition Ecological Landscape, although it is also found in several other ecological landscapes. It prefers slow-moving, cool, clear headwaters of river systems, with overhanging riparian vegetation, especially grasses, forbs, and low shrubs. A preferred stream would feature a succession of riffles necessary for spawning, and pools inhabited during the nonbreeding season. The redside dace is sensitive to environmental disturbances, and populations in Wisconsin have become isolated because land use changes have changed cool, clear water habitat to warm, turbid habitat. Coolwater refuge areas should be identified, protected, or restored. Although cause and effect are uncertain, redside dace have disappeared from waters into which the nonnative brown trout has been introduced. It is unique among minnows because it is the only member of that group to routinely feed on flying insects by leaping from the water.

The Forest Transition Ecological Landscape was identified by the Wisconsin Wildlife Action Plan (WDNR 2005b) as the most important ecological landscape in the state for the eastern red bat (*Lasiurus borealis*). It was closely associated with cool and coldwater streams. Like most bats, the eastern red bat is insectivorous, eating primarily moths. It also preys heavily on beetles, flies, and other insects. Eastern red bats roost in mature riparian forests that are close to edge habitat, open water, or fields. They prefer to roost in tall, large-diameter deciduous trees such as elms and maples (WDNR 2015a). Eastern red bats forage along forest-field edges, forest gaps, and riparian areas due to its large body size, wing shape, and

Redside dace (Wisconsin Special Concern) is a coolwater fish sensitive to excessive turbidity. Photo by John Lyons, Wisconsin DNR.

Significant Wildlife in the Forest Transition Ecological Landscape

- The eastern part of the ecological landscape offers opportunities for large-scale forest management for area sensitive forest interior birds and those using mature forests.
- Large northern white-cedar swamps, often associated with headwaters streams, occur in the eastern part of the ecological landscape and support wildlife species using these habitats.
- The larger blocks of forest in the western part of the ecological landscape include dry-mesic forests of oak and oak mixed with pine, both of which provide important wildlife habitat.
- The abundance of open habitat has made grassland management a priority in the central part of the Forest Transition ecological landscape. One of the key species, the Greater Prairie-Chicken, now occurs only here and in the Central Sand Plains Ecological Landscape.
- On the southeast edge of the ecological landscape, small cool- and coldwater streams flow from springs in a moraine and support native brook trout and rare invertebrates.
- The upper Wolf River flows through the eastern part of the ecological landscape. The Wolf and its tributaries are known for their excellent water quality and significant aquatic life. The trout resource has been prized by anglers for many decades.
- Important streams in the central part of the Forest Transition include the Big Eau Pleine, Rib, Plover, Prairie, and Eau Claire Rivers. Each of these supports important aquatic biota.
- The western portion of this ecological landscape includes local concentrations of kettle lakes and several important rivers, including the St. Croix, Apple, Willow, and Red Cedar.
- The lower St. Croix River is part of a National Scenic Riverway, administered by the National Park Service.
- It supports exceptionally high fish and mussel diversity, hosts large numbers of migratory birds, and the extensive floodplain and adjacent forested slopes provide important habitat for bottomland hardwood, upland forest, and marsh species.
- Major river corridors such as the Wisconsin, Black, Chippewa, Wolf, and St. Croix are important connectors between habitats within the Forest Transition and between ecological landscapes.
- Rare species for which there are important management opportunities include eastern red bat, black redhorse, crystal darter, redside dace, and several mussels.

The winged mapleleaf is a globally rare mussel that is now listed as endangered by both state and federal governments. A significant population of this imperiled species inhabits the lower St. Croix River. Photo by Lisie Kitchel, Wisconsin DNR.

echolocation call. Removal of roosting habitat and loss of foraging habitat can adversely affect and reduce local breeding populations. Protection and restoration of summer roosting areas and foraging sites are needed.

There are diverse mussel communities in some of the streams in this ecological landscape, especially the lower St. Croix River. Species found in the lower St. Croix include spectacle case, purple wartyback, butterfly, elephant ear, snuffbox, Higgins' eye, winged mapleleaf, monkeyface, salamander mussel, and buckhorn. Some of these species are rare, and some are federally and/or state listed as endangered or threatened. The world's only known viable population of the U.S. Endangered/Wisconsin Endangered winged mapleleaf mussel occupies the lower St. Croix for a distance of 12 miles below the St. Croix Falls dam. Many other rare mussels and several rare fish also dwell in this section of the lower St. Croix. Careful management of upstream dams to provide adequate water for the mussels in these streams and protection of watersheds to prevent siltation is needed.

Socially Important Fauna. Species such as white-tailed deer, American black bear, American beaver, North American river otter, Ruffed Grouse (*Bonasa umbellus*), American Woodcock (*Scolopax minor*), Mallard (*Anas platyrhynchos*), and Wood Duck (*Aix sponsa*) are all important for hunting, trapping, and wildlife viewing in the Forest Transition. This ecological landscape has an important warmwater fishery that supports populations of northern pike, walleye, small mouth and largemouth (*Micropterus salmoides*) bass, bluegill (*Lepomis macrochirus*), yellow perch (*Perca flavescens*), and other panfish sought by anglers. It has important coldwater streams for brook trout. There are also coldwater streams here, which now support introduced populations of nonnative salmonids such as brown trout and, to a lesser extent, rainbow trout.

Wildlife Habitats and Communities. The Forest Transition Ecological Landscape occurs along a large portion of the Tension Zone at the junction of the northern mixed conifer-hardwood forest and the southern prairie/forest region. It is also at the east-west boundary for some major tree species (e.g., American beech and eastern hemlock). Therefore the Forest Transition has a mix of both northern and southern species, as well as some species that occur only in the eastern or western part of the ecological landscape. Although historically this ecological landscape was primarily forested, it now has only about 40% forest, and much of what remains is highly fragmented by agricultural fields. The major exception is at the eastern edge of the Forest Transition, which includes significant parts of the still heavily forested Menominee Indian Reservation and Chequamegon-Nicolet National Forest.

Wildlife species most common here are those that inhabit forest edge and open habitats, with few species uniquely concentrated here. However, there are many opportunities for wildlife management. Priority wildlife habitats in this ecological landscape include large blocks of older forest, surrogate grasslands, medium-sized rivers and streams, and connecting corridors between southern and northern Wisconsin.

This ecological landscape plays an important role in the management of shorebird habitat, at sites such as the Big Eau Pleine Flowage and other flowages and impoundments (WDNR 2008b). Use of dams, dikes, and water control structures can raise or lower water levels to create habitats that benefit shorebirds during their migration periods. Migration phenology as well as species-specific habitat requirements must be considered when managing for shorebirds. See Helmers (1992) and Szalay et al. (2000) for existing national and regional shorebird conservation plans for guidelines on managing shorebird habitat.

Species of Greatest Conservation Need that would benefit from management attention at appropriate sites within the ecological landscape include the four-toed salamander (*Hemidactylium scutatum*), pickerel frog (*Lithobates palustris*), wood turtle, Bald Eagle, Black-billed Cuckoo (*Coccyzus erythropthalmus*), Black-throated Blue Warbler (*Setophaga caerulescens,* listed as *Dendroica caerulescens* in the Wisconsin Natural Heritage Working List), Canada Warbler (*Cardellina canadensis,* listed as *Wilsonia canadensis* in the Wisconsin Natural Heritage Working List), Least Flycatcher (*Empidonax minimus*), Northern Goshawk (*Accipiter gentilis*), Red-shouldered Hawk, Veery (*Catharus fuscescens*), Wood Thrush (*Hylocichla mustelina*), eastern red bat, hoary bat (*Lasiurus cinereus*), northern flying squirrel (*Glaucomys sabrinus*), silver-haired bat (*Lasionycteris noctivagans*), water shrew (*Sorex palustris*), woodland jumping mouse (*Napaeozapus insignis*), and West Virginia white butterfly (*Pieris virginiensis*) (WDNR 2005b). Restoration, management, and protection of northern hardwood forests for species, age class, patch size, and structural diversity will benefit Species of Greatest Conservation Need. Reforestation of marginal agricultural lands to reduce forest fragmentation and hard edge and increase the area of forested habitat would also be helpful to these species.

Forest Wildlife. The eastern part of the ecological landscape offers opportunities for large-scale forest management. There are still relatively large blocks of forest here, composed mostly of northern hardwoods, hemlock hardwoods, aspen-birch, and northern white-cedar. Public lands, such as the Lakewood District of the Chequamegon-Nicolet National Forest, have potential for area sensitive birds inhabiting mature forests such as the Northern Goshawk, Red-shouldered Hawk, Cerulean Warbler, and Black-throated Blue Warbler. Early successional forest provides habitat for species such as white-tailed deer, Ruffed Grouse, American Woodcock, Chestnut-sided Warbler (*Setophaga pensylvanica*), and Golden-winged Warbler (*Vermivora chrysoptera*).

The vast forests of the Menominee Indian Reservation (also in the eastern part of the ecological landscape) include older, but managed, hemlock-hardwood forests, scattered lakes and spring ponds, and intact forested watersheds, streams, and springs. The diverse, uneven-aged Menominee forests have been managed sustainably for over 140 years and still contain structural features that are now missing from almost all of Wisconsin's managed forests. These forests support a rich avifauna and are considered core Wisconsin habitat for species such as Black-throated Blue and Canada Warblers (Steele 2007). The Menominee forests also support large populations of Red-shouldered Hawk, Least Flycatcher, Veery, Wood Thrush, Blackburnian Warbler (*Setophaga fusca*), Black-throated Green Warbler (*Setophaga virens*), and Ovenbird (*Seiurus aurocapilla*).

Large northern white-cedar swamps, mixed with some black spruce and tamarack, are often associated with headwaters streams, are common in the eastern part of the ecological landscape, and provide habitat for additional wildlife species. The northern white-cedar swamps on the Menominee Indian Reservation are relatively undisturbed and represent core habitat areas for Winter Wren (*Troglodytes hiemalis*), Hermit Thrush (*Catharus guttatus*), Nashville Warbler (*Oreothlypis ruficapilla*), and Canada Warbler. Preservation of these northern white-cedar swamps will benefit these and many other wildlife species.

In the central portion of the ecological landscape, forests are fragmented and usually occur in smaller, more isolated patches. However, some of these remnants (mostly northern hardwoods or hemlock hardwoods) are floristically rich and offer structural features that are uncommon in this part of the Forest Transition. Examples occur at the dalles of the Eau Claire River and on public lands along the Big Eau Pleine River. Rib Mountain State Park occurs in this area, but the forest is younger, and the park now has a large white-tailed deer population that has negatively impacted the forest understory.

Relatively large blocks of forest can also be found in the western part of the Forest Transition Ecological Landscape. Forests dominated by oaks or oaks mixed with eastern white pine are common here. Straight Lake State Park, in addition to being an important geological site, has extensive mature, oak-dominated forests that support many forest bird species, including the highest density of the Wisconsin Threatened Cerulean Warbler in northern Wisconsin (WDNR 2005b). Because of the abundant kettle lakes in this part of the Forest Transition, including some that are lightly developed or undeveloped, the Bald Eagle, Osprey, and Trumpeter Swan (*Cygnus buccinator*) use the area. The area around Haugen-Birchwood and south of Balsam Lake has extensive forests that support many rare birds (such as Cerulean and Black-throated Blue Warblers).

The Wisconsin Special Concern Black-throated Blue Warbler nests near the ground in dense patches of shrubs or saplings within extensive areas of older Northern Mesic Forest such as those found on the Menominee Indian Reservation and in parts of the Chequamegon-Nicolet National Forest. Photo by Steve Maslowski.

Although the Cerulean Warbler breeds primarily in "southern" hardwood forests, the larger, older stands of white and northern red oaks occurring in the western part of the Forest Transition Ecological Landscape support good numbers. Photo by Dan Jackson.

The St. Croix River corridor in the western part of the Forest Transition provides breeding habitat for many bird species, especially in floodplain forests. Sensitive species using this area include Red-shouldered Hawk, Cerulean Warbler, Prothonotary Warbler (*Protonotaria citrea*), and Louisiana Waterthrush (*Parkesia motacilla*, listed as *Seiurus motacilla* on the Wisconsin Natural Heritage Working List). More common species include Eastern Wood-Pewee (*Contopus virens*); Yellow-throated Vireo (*Vireo flavifrons*); Bank (*Riparia riparia*), Cliff (*Petrochelidon pyrrhonota*), and Northern Rough-winged (*Stelgidopteryx serripennis*) Swallows; Bald Eagle; Hooded Merganser (*Lophodytes cucullatus*); Belted Kingfisher (*Megaceryle alcyon*); American Bittern (*Botaurus lentiginosus*); and Marsh Wren (*Cistothorus palustris*). Great Blue Heron (*Ardea herodias*) rookeries (Steele 2007) occur along this stretch of the St. Croix, which also hosts winter concentrations of Bald Eagles and Trumpeter Swans where the river remains open. There is heavy use of this north-south river corridor by many species of migrating birds.

Grassland Wildlife. In the central part of the Forest Transition Ecological Landscape, management for grassland species is possible because of the abundance of open land, including hayfields, pastures, row crops, and herbaceous wetlands. Species of Greatest Conservation Need that would benefit from grassland management include Greater Prairie-Chicken (see above), American Golden-Plover (*Pluvialis dominica*), Blue-winged Teal (*Anas discors*), Bobolink (*Dolichonyx oryzivorus*), Brown Thrasher (*Toxostoma rufum*), Dickcissel (*Spiza americana*), Dunlin (*Calidris alpina*), Eastern Meadowlark (*Sturnella magna*), Field Sparrow (*Spizella pusilla*), Grasshopper Sparrow (*Ammodramus savannarum*), Henslow's Sparrow, Northern Harrier (*Circus cyaneus*), Short-billed Dowitcher (*Limnodromus griseus*), Short-eared Owl (*Asio flammeus*), Upland Sandpiper (*Bartramia longicauda*), Western Meadowlark (*Sturnella neglecta*), Willow Flycatcher (*Empidonax traillii*), regal fritillary (*Speyeria idalia*), and Ottoe skipper (*Hesperia ottoe*) (WDNR 2005b). The Central Grasslands Project has been established to increase the amount of available grassland habitat for wildlife and includes part of this ecological landscape (WDNR 2012a).

Aquatic Wildlife. Rivers, streams, lakes and wetlands in this ecological landscape provide important habitat for many rare aquatic species. These features support 16 rare mussel species, including 50% of the statewide occurrences of both the endangered elephant ear and winged mapleleaf; seven species of rare dragonflies, including 33% of the statewide occurrences of the endangered Saint Croix snaketail; 18 species of rare fish, including 50% of the statewide occurrences of the Wisconsin Endangered black redhorse; two rare water beetles; one mammal; and several birds.

Many lakes in the Forest Transition have an abundance of desirable game and pan fish, especially largemouth bass, walleye, northern pike, black crappie (*Pomoxis nigromaculatus*), and bluegill. Historical stocking of fish not naturally found in some of these lakes (such as walleye, a species highly desired by anglers) has altered fish communities in some stocked lakes here from what they were before Euro-American settlement, creating occasional present-day population management complexities in balancing angler desires for large game fish or panfish while maintaining a healthy base of forage fish (Benike 2006).

Black redhorse (Wisconsin Endangered) inhabits medium-sized to small streams with swift currents and gravel, bedrock, or sand bottoms. Photo by John Lyons, Wisconsin DNR.

A number of lakes, including some that are larger and heavily developed as well as others that are small and less developed, maintain high to very high water quality conditions and support high species diversity including populations of rare fish and aquatic invertebrates. As examples of their habitat suitability for rare species, Archibald, Balsam, Bone, Half Moon, Long, Wapogasset, and other lakes support banded killifish (*Fundulus diaphanous*, Wisconsin Special Concern—a species whose population trend is unknown); weed shiner (*Notropis texanus,* Wisconsin Special Concern) inhabits Hemlock Lake and Lake Chetac; and Upper Bass and Rainbow lakes support lake sturgeon (Wisconsin Special Concern). Long and Grenlie lakes support elktoe mussel (*Alasmidonta marginata,* Wisconsin Special Concern); Keller and Rollofson lakes support a rare crawling water beetle (*Haliplus pantherinus,* Wisconsin Special Concern); and Myklebust Lake holds a population of a rare water scavenger beetle (*Laccobius agilis*) and is the only lake in the Forest Transition Ecological Landscape where this species occurs. Forest Transition lakes support 31% of the known statewide occurrences of the latter species (Appendix 11.C).

On the southeast edge of the ecological landscape, small, cool, and coldwater streams and creeks flow from springs in a hummocky end moraine of the Horicon Formation Maple View Member and are high quality coldwater streams that support trout. The headwaters often support native brook trout and rare invertebrates, with the lower reaches supporting nonnative brown trout. The upper Wolf River flows through this part of the ecological landscape and is known for its excellent water quality and trout resources as well as for its aquatic invertebrates. The Oconto River and several of its important tributaries flow through this area and also support a rich aquatic biota.

The eastern part of the ecological landscape has numerous kettle lakes, especially in the Lakewood area of northern Oconto County. Shores of these lakes are mostly privately owned and provide habitat for many fish (e.g., small and largemouth bass, walleye, and panfish). Also found here are unusual ***marl*** lakes. Marl lakes are high pH lakes that, if the amount of carbonate is high enough, will react with ***calcium*** in the water to form $CaCO_3$ (marl). Marl precipitates out, leaving a white substance in the sediment and sometimes even producing elaborate underwater formations. Marl can often be observed as a white precipitate on plant leaves in these lakes. The highest concentration of good quality brook trout streams is in the northeastern portion of the Forest Transition, in Langlade and Oconto counties (e.g., the East Branch of the Eau Claire River and the Evergreen River).

In the central part of the Forest Transition Ecological Landscape, important streams include the Big Eau Pleine, Big Rib, Plover, Prairie, and Eau Claire rivers. Some support ecologically and socially important aquatic biota and are important trout streams. Important fish species include brook trout, northern pike, walleye, smallmouth and largemouth bass, and panfish. The Prairie and Plover rivers have major brown trout fisheries. Species of Greatest Conservation Need in the Plover River and adjoining habitats include redside dace, four-toed salamander, pickerel frog, wood turtle, Osprey, eastern red bat, hoary bat, northern long-eared bat (*Myotis septentrionalis*),[2] water shrew, lancet clubtail (*Gomphus exilis*), and sand snaketail (*Ophiogomphus smithi*) (WDNR 2005b).

The western portion of the Forest Transition includes local concentrations of kettle lakes as well as stretches of several important rivers, including the St. Croix, Apple, Willow, and Red Cedar. Important fish species in streams include brook trout, nonnative brown and rainbow trout, and other fish species. Kettle lakes formed by buried blocks of ice in the Chippewa Lobe of the last glaciation support northern pike, walleye, small and largemouth bass, and pan fish. Abundant populations of muskellunge are found in a number of lakes, such as Bone and Deer in Polk County.

The lower St. Croix River forms the western border of the Forest Transition Ecological Landscape, where it is bordered by igneous bedrock features such as cliffs and glades, pine forests, oak forests, floodplain forests, springs, and seeps. The stretch of the lower St. Croix flowing through the Forest Transition is entirely within the St. Croix National Scenic Riverway, which is administered by the National Park Service and managed jointly by the Minnesota and Wisconsin Departments of Natural Resources agencies (USNPS, WDNR, and MDNR 2002). The stretch of the St. Croix immediately below St. Croix Falls has good populations of the Wisconsin Endangered crystal darter and the Wisconsin Threatened gilt darter, river redhorse, and greater redhorse.

The lake sturgeon is found in this stretch of the St. Croix River. Lake sturgeon habitat includes firm bottom flats for young of the year. For a long time, operation of the St. Croix Falls Dam was for peak power generation, which is believed to have contributed to the creation of numerous deep pools in this reach below the dam. These pools provide essential cover for adult sturgeon, as opposed to the shallower stretches of the impoundment upstream of the dam (Indianhead Flowage). (Since 2006 the owner, Northern States Power, has agreed to use run-of-the-river power production in order to protect mussel habitat). Evidence suggests that adult sturgeon were overexploited by largely unregulated angling methods through the 1950s. Despite more restrictive regulations in the 1970s and 1980s, the population continued to decline, and the river was closed to sturgeon fishing in 1994. An interagency sturgeon management plan for the upper St. Croix (including that portion of the Forest Transition above the St. Croix Falls dam) was established in 2004. Recent sampling shows that, while the adult population above the dam is still low, natural recruitment is increasing. The lake sturgeon population is expected to recover without restocking programs that risk compromising genetic diversity (Damman 2009). However, while sturgeon longevity contributes to some genetic ***resilience*** in the face of population isolation due to dams, genetic diversity would benefit from reconnecting the St. Croix above the dam with a number of its tributaries. Also, the population remains too low to withstand any angler harvest (Wendel and Frank 2012).

The aquatic habitat in this stream reach of the St. Croix River below the dam is ideal for burrowing invertebrates, consisting of a mix of gravel and cobble, with some shifting sand farther downstream of the dam. The rock component provides a firm substrate favored by several important mussel species and other aquatic invertebrates. Therefore, the diversity of fish, mussels, and other species associated with specific bottom substrates is exceptionally high. The diversity of aquatic invertebrates in the lower St. Croix River may be the highest of any river of comparable size in Wisconsin, totaling more species overall (including 40 freshwater mussel species alone) and with more rare species (28) than other rivers known to support a high diversity of aquatic organisms (including the lower Chippewa, South Fork of the Flambeau, and Wolf (W.A, Smith, Wisconsin DNR, personal communication). The species comprising this diverse aquatic community in the lower St. Croix include some that are Wisconsin Special Concern, others that are Wisconsin Endangered or Wisconsin Threatened, and several that are U.S. Endangered. Among these

[2]On 6/1/2011, four bats were added to the Wisconsin threatened species list: big brown bat (*Eptesicus fuscus*), little brown bat (*Myotis lucifugus*), northern long-eared bat (*Myotis septentrionalis*), and eastern pipistrelle (*Perimyotis subflavus*). This was an emergency listing due to the rapid spread of the often fatal disease known as white-nose syndrome. The four Wisconsin "cave" bats are especially vulnerable because they may travel great distances and spend time together in confined spaces, hibernating over the winter in caves and mines where they can become infected with the fungus that causes white-nose. Some hibernacula have experienced mortality rates greater than 98%.

at-risk species are the crystal darter, the St. Croix snaketail dragonfly, and the Higgins' eye and winged mapleleaf mussels. In addition to being a biodiversity hotspot, the St. Croix River is one of the top smallmouth bass rivers in the nation and receives heavy use by boaters and other recreationists (WDNR 2001b).

The middle section of the Chippewa River in Chippewa County (from the Lake Wissota tail waters above Chippewa Falls, upstream to the spillway of the Cornell Dam) in this ecological landscape harbors lake sturgeon, but its status is not well known nor has the extent and suitability of sturgeon habitat been clarified. A study is ongoing (2009) to quantify sturgeon populations in Lake Wissota and in river stretches below the dam. The Federal Energy Regulatory Commission relicensing process included improvements in sturgeon habitat, including minimum flows and reduced flow fluctuations below dams, and a reduction of major, late-winter drawdowns in Lake Wissota.

The stretch of the Wisconsin River that flows through this ecological landscape supports at least three rare species: the black redhorse, black buffalo, and the elktoe mussel**.**

Other warmwater streams supporting rare species include the Eau Claire River, with a population of Wisconsin Endangered black redhorse and at least 14 other rare species. The Trappe River has the Wisconsin Special Concern redside dace, which is also found in streams throughout much of the central portion of this ecological landscape, including the Big Rib, Little Rib, Big Sandy, Plover, and upper Black river systems. The Yellow River in Barron County (a Red Cedar River tributary), supports the Wisconsin Threatened greater redhorse, which is also found throughout the upper Red Cedar River system and in the St. Croix River. Other warmwater streams supporting rare species include the North Fork of the Eau Claire and Popple rivers. In addition to the rivers and streams discussed above, Species of Greatest Conservation Need are found in the Big Rib and Little Rib river systems, Little Wolf River, and Wolf River and adjacent habitats.

The Straight Lake wetlands (within Straight Lake State Wildlife Area and Straight Lake State Park, Polk County) and the Mead Wildlife Area wetlands (in Marathon, Wood and Portage counties) host many rare invertebrate species, including two of only three known Wisconsin sites for the Wisconsin Special Concern dragonfly, the subarctic darner (*Aeshna subartica*). They also support populations of another rare dragonfly, the Wisconsin Special Concern lake darner (*Aeshna eremita*).

Wildlife Corridors. Corridors of major rivers (e.g., the Wisconsin, Wolf, Black, Chippewa, and St. Croix) cross this ecological landscape and can provide connectivity for habitats and landscapes between northern and southern Wisconsin. For example, maintaining an undeveloped, continuous riparian habitat including forests and wetlands along the Black River could link portions of the Chequamegon-Nicolet National Forest, Black River State Forest, Big Creek State Fisheries Area,

Basalt cliffs and eastern white pine-dominated forests flank this stretch of the lower St. Croix River in Polk County. The St. Croix supports an exceptionally diverse assemblage of aquatic organisms, many of them rare. The river corridor provides important habitat for numerous migratory and resident birds. Photo by Eric Epstein.

Van Loon State Wildlife Area, and the Upper Mississippi River National Wildlife and Fish Refuge. These rivers and adjacent habitats are important north-south dispersal corridors for American black bear, gray wolf, fisher, bobcat (*Lynx rufus*), migrating birds, and many other species of fish and wildlife. Maintaining these corridors will become increasingly important to facilitate the movements of many plant, animal, and aquatic species in an era of climate change and to mitigate the negative impacts of habitat fragmentation and isolation.

These river corridors also provide important breeding habitat for those species associated with floodplain forest; with other riverine wetlands such as marshes, sedge meadows, and shrub swamps; and with adjacent upland habitats. These rivers also provide habitat for many aquatic species. A diverse warmwater fishery occurs in these rivers, which includes important game species such as northern pike, smallmouth and largemouth bass, walleye, panfish, and many rare species, including lake sturgeon. Continuous undammed stretches of these rivers allow fish and other aquatic species to move freely between habitats used for spawning, foraging, and escape. Maintaining undeveloped shorelines and keeping corridors intact and vegetated with native species where possible will support native biota over the long-term and will help to maintain good water quality that will benefit aquatic (and other) organisms.

Natural and Human Disturbances

Historically, the Forest Transition was almost completely forested prior to settlement by Euro-Americans. The major forest communities here before Euro-American settlement were mesic maple-basswood or hemlock-hardwood forests, with American beech as an important canopy component in the eastern part of the ecological landscape. Oak forests were common in the westernmost portions of the Forest Transition and at scattered locations along the southern margins of the ecological landscape (see the map "Vegetation of the Forest Transition Ecological Landscape in the Mid-1800s" in Appendix 11.K at the end of the chapter). The abundance, composition, and structural characteristics of the forests here have been greatly changed by human influences since Euro-American settlement. Agricultural development has extensively altered the vegetation and natural disturbance regimes.

WISCLAND land use/land cover data from 1992 show that 31% (1,452,991 acres) of the ecological landscape was in agricultural use, 14% (663,989 acres) was grassland (this is virtually all nonnative grass, and much of it was also used for agricultural purposes, such as pasturage), 6% (272,829 acres) was nonforested wetland, and 44% (2,031,441 acres) was forested (WDNR 1993). The remainder of the ecological landscape was open water, bare land, shrub swamp, and urban areas in 1992. Generally, the eastern part of the ecological landscape is more forested, the central part is heavily agricultural with scattered grasslands and woodlots, and the western part is partially forested interspersed with agriculture.

Fire, Wind, and Flooding

Fire was likely a minor historical disturbance in most of the Forest Transition, although it may have played a more significant role in the far western, southwestern, and southeastern parts of the ecological landscape. Soil types and most of the forest vegetation (Northern Mesic Forest) here was fire resistant, suggesting that fires were infrequent. In areas where there were oak, pine, and mixed pine-oak forests (west, far southeast, and southwest parts of the ecological landscape), fire was likely a more significant disturbance, but the fire return interval would have been much longer than 15 years (Dickmann and Cleland 2002). Eastern white pine was sometimes a component of mesic forests, and pine forests occur on coarse-textured moraines and in association with bedrock, (e.g., on basalt along the St. Croix River near St. Croix Falls and on sandstone in some places in Clark County). This indicates that fire may have been an occasional disturbance with stand-replacing return intervals that ranged from about 75 to 250 years, based on studies in other parts of the Lake States with comparable landforms dominated by mixed pine-oak-aspen forests.

Historically, windthrow was the primary natural disturbance that affected this ecological landscape. Storms most often resulted in many small wind-fall patches (Frelich and Lorimer 1991), but some large-scale catastrophic windthrow events occurred, and these made up the majority of the windthrow area prior to Euro-American settlement (Schulte and Mladenoff 2005). Although not in this ecological landscape, an example of large-scale catastrophic windthrow occurred just to the north of the Forest Transition (in the North Central Forest Ecological Landscape) on July 4, 1977, when a squall line associated with severe thunderstorms crossed eastern Minnesota and north central Wisconsin and uprooted tress on an estimated 344,000 hectares of forestland (Canham and Loucks 1984). Estimated return time for such catastrophic wind throw events is about 1,200 years. These catastrophic wind events can result in direct forest stand replacement (either by early successional species or by a forest composed of species similar to what had been leveled) and also provide downed and dead trees and slash as fuel for fires.

Smaller-scale severe windthrow events occurred more frequently (Schulte and Mladenoff 2005). Because intervals between severe wind events were longer than the maximum age of shade tolerant trees, Frelich and Lorimer (1991) suggested that wind-prone landscapes were dominated by mature to old-growth forests. Light to moderate levels of windthrow likely facilitated or maintained a dominance of eastern hemlock, which was multi-aged, while heavy windthrow may have favored hardwoods (Schulte and Mladenoff 2005). Yellow birch, which is less shade tolerant than eastern hemlock, may have been dependent on heavier windthrow disturbance to provide suitable germination substrates and light and competition conditions that would facilitate growth beyond the sapling stage.

Three sources of severe winds that can cause windthrow have been suggested (Canham and Loucks 1984). Intense low pressure systems can generate strong winds that cause trees to be uprooted and create canopy gaps but seldom result in complete canopy removal. Tornadoes can cause complete canopy removal, but the swaths usually occur in narrow (less than one-quarter-mile wide), linear strips. The most common wind force that has caused complete loss of canopy in large patches in Wisconsin's northern forests has been from thunderstorm ***downbursts***. Many counties of the Forest Transition Ecological Landscape have had one thunderstorm with winds of 100 mph or greater during 1970–2012, and most counties in the ecological landscape have had from 5 to 12 thunderstorms with 74 mph winds or greater during that time period (NOAA 2014a).

Lightning is often associated with thunderstorms, which may also have strong winds. The following figures are for recorded lightning strikes and can only be used an index to compare among ecological landscapes. Undoubtedly there are many more lightning strikes away from human structures that occur and are unrecorded. The number of recorded lightning strikes in this ecological landscape is similar to other parts of northern Wisconsin, with most counties having less than ten strikes during 1982–2012 (NOAA 2014b). Marathon County is the only county in the ecological landscape that recorded a larger number of lightning strikes (21) during this time period.

Wind impacts may have increased from historical conditions because the forests in much of the Forest Transition Ecological Landscape are highly fragmented, and since the edges of woodlots are more exposed to strong winds, they may be more subject to windthrow. However, there is much less forest in this ecological landscape now compared to what it was before Euro-American settlement, and the present forest is much younger and therefore somewhat less vulnerable to windthrow. Windthrow, including severe windthrow, still occurs here as a natural disturbance, but it is unknown if its frequency or severity is greater or less than it was prior to Euro-American settlement.

Although ice storms are infrequent events with localized impacts, they can open forest canopies significantly (especially when followed by strong winds), altering forest structure and future composition.

The extent and frequency of flood disturbance prior to Euro-American settlement is unknown. Peak stream flow data, although highly variable, do not indicate any significant increasing or decreasing trends for many rivers in this ecological landscape (USGS 2009). However, it is possible that flooding has been reduced from historical levels in some places due to a combination of the effects of dams and other water control structures. It is also possible that extensive removal of forest cover and drainage of wetlands and increase in agricultural lands in other areas have increased the amount and rate of runoff, resulting in more flooding.

Alterations to flood regimes affect food webs in streams and riparian zones. Floodplain forests found along rivers and streams were historically disturbed by periodic episodes of high water. Flood disturbances include scouring by water, ice, and debris, sediment deposition, and periods of saturation or inundation interspersed with dry conditions. Vegetative composition, including successional trajectories, is affected by timing and severity of flooding. In some parts of the Forest Transition, flood regimes have been affected by dam construction as well as wetland drainage and filling, channelization, streambank stabilization, shoreline "hardening," replacement of riparian vegetation and wetlands with agricultural fields or lawns, and development of transportation infrastructure.

Forest Insects and Diseases

The Forest Transition Ecological Landscape is a heterogeneous area that stretches east to west across much of the middle of the state, straddling the Tension Zone between northern and southern Wisconsin. It supports a wide variety of forest communities and dominant species, each of them associated with different insects and diseases. Thus, there is a diverse array of pests and pathogens that can periodically affect forests here.

Aspen can be impacted by forest tent caterpillar (*Malacosoma disstria*), aspen heart rot fungus (*Phellinus tremulae*), and aspen Hypoxylon canker fungus (*Hypoxylon mammatum*). White birch can be affected by bronze birch borer (*Agrilus anxius*), and drought can predispose these and other tree species to many diseases.

Conifers can be affected by a number of insects and diseases. Eastern white pine is an important canopy (and formerly, a supercanopy) species in the mesic and dry-mesic forests of this ecological landscape, especially in the western and eastern areas but also along some rivers and on coarse-textured end moraines. However, jack pine (*Pinus banksiana*) is rare, and red pine is very limited in occurrence here. Red, eastern white, and jack pines, can be affected by Annosum root rot, caused by the fungus *Heterobasidion annosum*, particularly in pine plantations. Red pines are also subject to "pocket mortality," caused by a complex of insects and the fungal species *Leptographium terrebrantis* and *L. procerum*. Red pine is also susceptible to Diplodia pine blight fungus (*Diplodia pinea*) and pine sawfly (*Neodiprion* spp., *Diprion* spp.). White pine blister rust is an introduced fungal disease caused by *Cronartium ribicola*. The jack pine budworm (*Choristoneura pinus*) is a native insect whose infestations can cause large-scale mortality of mature jack pine, setting up fuel conditions for catastrophic fire.

Oaks are affected by several organisms. Gypsy moth (*Lymantria dispar*) is a nonnative insect, currently becoming established in this ecological landscape, which will periodically affect oak and aspen forests, among others. Dry conditions can facilitate gypsy moth population growth, leading to faster rates of spread and more frequent outbreaks after establishment. The two-lined chestnut borer (*Agrilus bilineatus)* is a bark-boring insect that attacks oaks. Oak wilt is a vascular disease caused by the native fungus *Ceratocystis fagacearum*.

Dutch elm disease is caused by the fungus *Ophiostoma ulmi*, which is transmitted by two species of elm bark beetles (*Hylurgopinus rufipes and Scolytus multistriatus*) or by root grafting. American elm (*Ulmus americana*) is more seriously affected than other elm species, but all of our native elm species are susceptible to the disease, as is the nonnative Siberian elm (*Ulmus pumila*). American elm has essentially been eliminated as a component of the forest overstory but is still a significant part of the understory and seedling layers in some areas. Its life span is typically now about 30 years before it succumbs to Dutch elm disease. The loss of American elm as a dominant tree has impacts on associated wildlife species because it provided nesting cavities for species such as Wood Duck. In bottomland hardwood forests, trees killed by Dutch elm disease create gaps that may be colonized by dense stands of the highly invasive reed canary grass (*Phalaris arundinacea*). When such infestations are heavy, tree regeneration can be difficult or even impossible, at least in the short- or mid-term. Dutch elm disease and reed canary grass have altered the structure and composition of several major forest types in this ecological landscape, especially Floodplain Forest, and to a lesser extent, mesic hardwood forests in which elm was a significant component.

Emerald ash borer (*Agrilus planipennis*) is an exotic insect native to Asia. The black ash-dominated hardwood swamps in this ecological landscape could be seriously affected by the emerald ash borer. This extremely serious forest pest has been confirmed in 31 Wisconsin counties as of early 2015. These counties have been placed under quarantine in an effort to help prevent the human-aided spread of the emerald ash borer, which may be present in ash nursery stock, ash firewood and timber, or other articles that could spread emerald ash borer into other parts of Wisconsin or other states. Some adjacent counties are also under quarantine because of their proximity to infestations in neighboring counties. Attempts to contain infestations in Michigan by destroying ash trees in areas where emerald ash borer was found have not been successful, perhaps because the insect was already well established before it was found and identified. The emerald ash borer typically kills a tree within one to three years. In greenhouse tests, the emerald ash borer has also been shown to feed on some shrub species such as privets (*Ligustrum* spp.) and lilacs (*Syringa* spp.), but it is still unknown as to whether shrub availability will contribute to its spread under field conditions. See the Wisconsin Emerald Ash Borer website (WDATCP 2015) for up-to-date information on its current distribution.

The emerald ash borer could have an impact on forest structure here, especially in floodplain forests and hardwood swamps. The forested floodplains of the Wisconsin, Chippewa, Wolf, and St. Croix rivers, where green ash (*Fraxinus pennsylvanica*) is common and sometimes a canopy co-dominant, could be dramatically altered if the green ash are killed and are not replaced by other tree species. Floodplain Forests provide important breeding habitat for a number of rare species and maintain connectivity between forested sites within and between ecological landscapes (this is especially true where agriculture is a dominant land use). Black ash occurs in hardwood swamps (sometimes in dense stands where it can be overwhelmingly dominant), along waterbodies (where it can be a minor component of floodplain forests), and on the margins of spring ponds and ephemeral ponds. It is susceptible to emerald ash borer attack, as green ash is.

As touched upon in preceding paragraphs, canopy gaps in bottomland hardwood forests, whether due to windthrow, insect infestation, disease, or logging, may be quickly colonized by the highly invasive reed canary grass. Germination, and growth of seedling trees under dense stands of reed canary grass, can be highly problematic.

More information about these forest diseases and insect pests of forest trees can be found at the Wisconsin DNR's forest health web page (WDNR 2015b) and at the U.S. Forest Service Northeastern Area forest health and economics web page (USFS 2015).

Invasive Species

Due to the levels of development and disturbance in many parts of the Forest Transition, there are nonnative invasive species that are established and already causing problems here. This ecological landscape is vulnerable to additional invasions and to the spread of already established invasive species to other lands and waters. Human travel is a major vector for transport and dispersal of a variety of invasive species, and tourism, recreation, other types of economic activity, well developed networks of roads and other infrastructure, and further development make this area ideal for initial introductions.

Invasive plants that are already posing problems in forests include glossy and common buckthorn (*Rhamnus frangula* and *R. cathartica*), nonnative honeysuckles (*Lonicera tatarica*, *L. morrowii,* and *L.* x *bella)*, garlic mustard (*Alliaria petiolata*), Japanese barberry (*Berberis thunbergii*), Dame's rocket (*Hesperis matronalis*), Japanese knotweed (*Polygonum cuspidatum*), and black locust (*Robinia pseudoacacia*). These species may initially colonize disturbed areas and edges but once established can continue to invade surrounding habitats, including forests.

The invasion of forests by European earthworms of the family Lumbricidae is a concern in this ecological landscape. While there were apparently no native earthworms in the glaciated parts of Wisconsin, including the Forest Transition, exotic earthworms appeared and spread with Euro-American settlement, primarily as discarded fishing bait (Hendrix and Bohlen 2002, Hale et al. 2005). Exotic earthworms can have dramatic impacts on forest soils and vegetation by greatly reducing organic matter (Hale et al. 2005), microbial biomass (Groffman et al. 2004), nutrient availability (Bohlen et al. 2004, Suarez et al. 2004), and fine-root biomass (Fisk et al. 2004). These physical changes in the forest floor reduce densities of tree seedlings and rare herbs (Gundale 2002) and can favor invasive plants (Kourtev et al. 1999).

Although native prairies are very rare in this ecological landscape, nonforested upland herbaceous vegetation occurs as several types of surrogate grasslands and along roads and other rights-of-way kept free of woody cover. Among the invasive plants found in such areas are spotted knapweed (*Centaurea biebersteinii*), wild parsnip (*Pastinaca sativa*), leafy spurge (*Euphorbia esula*), Canada thistle (*Cirsium arvense*), and common tansy (*Tanacetum vulgare*).

In aquatic and wetland ecosystems, Eurasian water-milfoil, curly pondweed, rusty crayfish, common reed (*Phragmites australis*), purple loosestrife, reed canary grass, and common carp are the primary problem species. The nonnative watercress (*Nasturtium officinale*) is common in some springs and headwaters streams where it may take over and become the dominant plant.

For more information on invasive species, see the Wisconsin DNR's invasive species web page (WDNR 2015d).

Land Use Impacts

Historical Impacts. Ecological impacts of large-scale logging in the latter half of the 19th century were immense in this ecological landscape, and some of those impacts persist today. Following the heavy deforestation of the Cutover, extensive, often intense fires burned through the slash and other debris left from the logging operations. Log drives to deliver logs to sawmills were a major disturbance on virtually every large river and many medium-sized streams in this ecological landscape. Dams were built on rivers to impound water, rivers were cleared of large woody material to facilitate movement of logs, river bottoms and banks were scoured during log drives, and deposition of bark and other woody debris changed the character of many water bodies. After extensive logging, parts of the Forest Transition attracted settlers who cleared much of the land, which was then converted to farms and used for agriculture. Much of the Forest Transition is now a patchwork of agricultural fields and rectilinear woodlots (with the exception of more extensive forests in the east and far west), rather than being an area almost entirely covered by forest. Dams built to generate hydropower have created impoundments and changed the flow characteristics and aquatic habitats of many streams and rivers.

Current Impacts. Current disturbances in the ecological landscape are largely due to human activities, such as the long-term conversion of land to agricultural production, residential areas, and the construction of roads and other permanent rights-of-way. Some effects are indirect, such as the high level of herbivory by white-tailed deer, which is largely the result of human activities that affect the size of white-tailed deer populations (see Chapter 5, "Current and Emerging Resource Issues," for a discussion of white-tailed deer impacts). A major difference from the effects of past natural disturbances is that today's impacts are multiple and pervasive, affecting most of the landscape almost constantly. Historically, most landscape ecosystems existed in a quasi steady-state condition where disturbances impacted parts of the area but typically moved around the landscape so that some portions were undisturbed for long periods of time.

Agriculture. Prior to Euro-American settlement, the Forest Transition EcologicalLandscape was characterized by an extensive ***matrix*** of northern hardwood and hemlock-hardwood forests, with scattered marshes, sedge meadows, bogs, conifer swamps, and floodplain forests. Much of the forested land has been converted to agricultural uses because of the favorable climate, gently rolling topography, and rich soils. In 1992, 57% of the ecological landscape was nonforested (versus 14% historically), with agriculture occurring on approximately 45% of the land (31% row crops and 14% pasture, hay, and small grains; WDNR 1993). Other nonforested land is open wetland, open water, urban, and bare ground. Widespread agriculture has created a matrix of farm fields, interspersed with small, scattered, patches of forest and wetland, in much of the Forest Transition. This benefits common and widely distributed species such as white-tailed deer and Wild Turkey but does not provide good habitat for area-sensitive forest interior species. Grassland bird habitat is largely restricted to surrogate grasslands and open wetlands in the heavily agricultural region in the central part of the ecological landscape, where there are pastures and idle grasslands that somewhat complement large-scale grassland-wetland management areas such as Mead, McMillan Marsh, and Paul J. Olson State Wildlife Areas.

Changes in Hydrology. Dams constructed to produce hydropower have fragmented riverine aquatic habitats and degraded or disrupted many river and stream characteristics and functions. Fish and other aquatic species are restricted in their movements to reaches either below or above a dam. Water-level manipulation activities at dams can affect species both upstream and downstream from the dam. For example, birds nesting in wetlands subject to inundation by dam management can have their nests flooded if water levels are raised too high during the breeding season. Species inhabiting in-stream areas below dams can be left without enough water to survive cold winters if too much water is held during critical winter periods. Hydrologic alterations due to dam and impoundment construction have changed the frequency, timing, magnitude, and duration of flood events, casting uncertainty on the long-term responses of vegetation within the floodplain.

*This aerial photo shows the high levels of habitat fragmentation and shoreline development that now characterize much of the Forest Transition Ecological Landscape west of the Menominee Indian Reservation. The linear shape crossing this scene diagonally from northwest to southeast is a natural feature, a **glacial tunnel channel**, which contains a stretch of the Straight River in Polk County. Photo by National Agricultural Imagery Program.*

Level glacial outwash plain east of Antigo, Langlade County, has been almost totally converted from hemlock-hardwood forest to cropland. Photo by Eric Epstein, Wisconsin DNR.

Changes to hydrology from road construction, agriculture, and other kinds of development have eliminated wetlands and altered or degraded others. The loss of wetlands has additional impacts such as increased sedimentation, larger pollutant and pesticide loads, and more frequent flooding on waterways downstream.

Conversion of bog, fen, meadow, or swamp communities to open marsh diminishes the amount of habitat available for native wetland plants and animals not adapted to marshes and can have ecological impacts on entire wetland ecosystems and species that depend on them. ***Type conversions*** may also create additional management and maintenance costs and challenges because the newly converted habitats will probably not be stable. Proposals to convert one habitat to another (especially when the proposal involves converting intact natural communities) need scrutiny at local and regional scales to clarify the impacts on the habitats that will be lost or gained and impacts on associated species.

Forest Management. In the eastern part of the Forest Transition Ecological Landscape, forest management is an activity of primary importance. A focus on stand-level forest management has resulted in many small to medium-sized patches of similar species composition and age-class structure, while at the broader scale there has been a loss of patch size diversity and age-class diversity (Schulte et al. 2007). With the exception of the Menominee Indian Reservation, there is a lack of older forests throughout this ecological landscape. The creation of large amounts of edge habitats has promoted habitat generalists at the expense of interior forest habitat specialists, area-sensitive species, and disturbance-sensitive species.

Ecological simplification and homogenization are taking place under current forest management practices that emphasize management for similar species and age classes (Schulte et al. 2007). Red maple (see Figure 11.5) is increasing at the expense of other tree species. Specialized or more sensitive ground flora (e.g., lilies, orchids, insect-pollinated species) are decreasing in abundance, while generalists and nonnative species are increasing (Rooney et al. 2004, Schulte et al. 2007). High white-tailed deer densities are causing a decline of browse sensitive species. Invasive species are being introduced through vehicular travel and other human activities and are outcompeting native species.

The practice of strip-cutting to regenerate northern white-cedar swamps, widely implemented in northeastern Wisconsin on federal lands during the 1970s, was generally unsuccessful. Regeneration problems were exacerbated, habitat fragmentation was increased, some rare species habitat was lost, and northern white-cedar-dominated forest habitat was converted to shrub swamp.

Much of the Menominee Indian Reservation escaped the heavy cutting and severe fires that accompanied Euro-American settlement of northern Wisconsin in the late 19th and early 20th centuries. This forest has unique attributes and has been managed since the mid-1850s. Photo by Mike Mossman, Wisconsin DNR.

Although not nearly as extensive in the Forest Transition as in some other ecological landscapes, such as those with extensive sandy soils, the development of pine plantations, when converted from native cover types, creates patches of monotypic, structurally and compositionally simplified forest. Although there may be economic advantages to plantations in some situations, they are generally poor white-tailed deer (Kohn 1974) and other wildlife habitat and seldom, if ever, support diverse assemblages of native plants and animals.

Forest openings have been created and maintained to provide additional habitat for white-tailed deer, which are already abundant in this ecological landscape. Creating new forest openings has been discontinued as an approved wildlife management practice by the Wisconsin DNR Wildlife Policy Team because of the already high white-tailed deer numbers and because this practice fragments the forest, sometimes degrading or destroying habitat that is important to forest interior species. However, existing artificial openings are still being maintained in some parts of northern Wisconsin. This practice helps maintain the white-tailed deer population at high levels, which can negatively affect native vegetation (Alverson et al. 1988, Alverson and Waller 1997). White-tailed deer populations have been above stated goals in the ecological landscape and should be maintained at or below established goals to avoid damaging forest vegetation. Research is needed to determine the densities of white-tailed deer that will not damage native ecosystems in Wisconsin.

Development. Dispersed residential development has occurred and is increasing throughout the Forest Transition but especially near larger cities (e.g., Wausau area and in the Wisconsin River valley and along the St. Croix River). Often development is occurring first in rings around lakes or next to rivers and then in the forests surrounding the lakes or rivers. This growth has increased housing and road densities here. Dispersed development brings with it permanent changes that can alter large sections of the ecological landscapes where it is occurring. It can result in habitat destruction, fragmentation, isolation, and loss of connectivity, as well as disrupt hydrology, facilitate the introduction and spread of invasive species, increase land values and the cost of public services, and contribute to wildfire risks. Other effects of dispersed development include an increase in generalist species and nonnative habitats (e.g., roads, utility rights-of-way, lawns, landscaping, golf courses, sand blankets, sand and gravel quarries), feeding of wildlife, and predation by free-ranging dogs and cats.

Shoreline development has altered habitat conditions and affected water quality of some aquatic systems. The placement of shoreline structures such as piers, boat lifts, and ramps can reduce the amount of nearshore submergent aquatic habitats that are beneficial to fish, amphibians, invertebrates, and other wildlife species. This has in turn caused a reduction in aquatic

Rib Mountain is a prominent quartzite bedrock feature in Marathon County. Developments include ski slopes, a golf course, and communications towers. Not shown are major and secondary roads, agricultural land, subdivisions, and a quarry. Photo by Eric Epstein, Wisconsin DNR.

and terrestrial species complexity, favoring habitat generalists over more sensitive and specialized plants and animals (see the "Land Use Impacts" section in Chapter 14, "Northern Highland Ecological Landscape," for a more detailed discussion of the impacts of shoreline development).

Management Opportunities for Important Ecological Features of the Forest Transition

Natural communities, waterbodies, and other significant habitats for native plants and animals have been grouped together as "ecological features" and identified as management opportunities when they

- occur together in close proximity, especially in repeatable patterns representative of a particular ecological landscape or group of ecological landscapes;
- offer compositional, structural, and functional attributes that are important for a variety of reasons and that may not necessarily be represented in a single stand;
- represent outstanding examples of natural features characteristic of a given ecological landscape;
- are adapted to and somewhat dependent on similar disturbance regimes;
- share hydrological linkage;
- increase the effective conservation area of a planning area or management unit, reduce excessive edge or other negative impacts, and/or connect otherwise isolated patches of similar habitat;
- potentially increase ecological viability when environmental or land use changes occur by including environmental gradients and connectivity among the other important management considerations;
- accommodate species needing large areas and/or those requiring more than one habitat;
- add habitat diversity that would otherwise not be present or maintained; and
- provide economies of scale for land and water managers.

A site's conservation potential may go unrecognized and unrealized when individual stands and habitat patches are managed as stand-alone entities. A landscape-scale approach that considers the context and history of an area, along with the types of communities, habitats, and species that are present, may provide the most benefits over the longest period of time. This does not imply that all of the communities and habitats associated with a given opportunity should be managed in the same way, at the same time, or at the same scale. Instead we suggest that planning and management efforts incorporate broader management considerations and address the variety of scales and structures approximating the ***natural range of variability*** within an ecological landscape, especially those that are currently missing, declining, or at the greatest risk of disappearing over time.

Both ecological and socioeconomic factors were considered when determining management opportunities. Integrating ecosystem management with socioeconomic activities can result in efficiencies in the use of land, tax revenues, and private capital. This type of integration can also help to generate broader and deeper support for sustainable ecosystem management. Statewide integrated opportunities can be found in Chapter 6, "Wisconsin's Ecological Features and Opportunities for Management."

Significant ecological management opportunities that have been identified for the Forest Transition Ecological Landscape include

- extensive mesic forests in the east with embedded wetlands, lakes, ponds, and streams;
- river corridors: Wisconsin, St. Croix, Chippewa, Black, Wolf, Eau Claire, Plover, and Big Rib rivers;
- dry-mesic forests of oak, pine, and mixed oak-pine;
- wetlands and waterbodies: conifer swamps, northern fens, sedge meadows, marshes, springs, and marl flats;
- bedrock habitats: St. Croix, Eau Claire, and Wolf rivers and Rib Mountain;
- surrogate grasslands, open habitats;
- miscellaneous opportunities: floristically rich mesic forests, pine forests, lakes, ephemeral ponds, spring ponds, spring runs, and headwaters streams.

Natural communities, community complexes, and important habitats for which there are management opportunities in this ecological landscape are listed in Table 11.2. Examples of locations where these important ecological places may be

Table 11.2. *Natural communities, aquatic features, and selected habitats associated with each ecological feature within the Forest Transition Ecological Landscape.*

Ecological features[a]	Natural communities,[b] aquatic features, and selected habitats
Extensive mesic forests (in the eastern part of the ecological landscape)	Northern Mesic Forest Northern Wet-Mesic Forest Northern Wet Forest Northern Sedge Meadow Southern Sedge Meadow Alder Thicket Open Bog/Poor Fen Emergent Marsh Wild Rice Marsh Submergent Marsh Ephemeral Pond Coldwater Stream Coolwater Stream Inland Lake Spring Pond Warmwater River Warmwater Stream
River corridors	Northern Dry-Mesic Forest Northern Mesic Forest Northern Hardwood Swamp Floodplain Forest Alder Thicket Shrub-carr Northern Sedge Meadow Southern Sedge Meadow Emergent Marsh Wild Rice Marsh Submergent Marsh Bedrock Glade Dry Cliff Moist Cliff Forested Seep Coldwater Stream Coolwater Stream Spring Pond Warmwater River Warmwater Stream River Dalles
Red and white oak forests, and eastern white pine-oak forests in west	Northern Dry-Mesic Forest Northern Mesic Forest Southern Dry-Mesic Forest Southern Mesic Forest Ephemeral Pond
Wetlands and waterbodies	Northern Wet Forest (Black Spruce Swamp, Tamarack Swamp) Northern Wet-Mesic Forest Northern Sedge Meadow Southern Sedge Meadow Open Bog/Poor Fen Emergent Marsh Wild Rice Marsh Submergent Marsh Inland Lake

Continued on next page

Table 11.2, *continued***.**

Ecological features[a]	Natural communities,[b] aquatic features, and selected habitats
Bedrock habitats	Northern Dry Forest Southern Dry Forest Bedrock Glade Dry Cliff Moist Cliff
Open landscapes	Northern Sedge Meadow Southern Sedge Meadow Surrogate Grassland Emergent Marsh Wild Rice Marsh Submergent Marsh
Miscellaneous (intact forest remnants, isolated features of good quality, scattered rare species populations)	Northern Mesic Forest Northern Wet-mesic Forest Northern Wet Forest Northern Hardwood Swamp Coldwater Stream Coolwater Stream Impoundment Inland Lake Spring Pond Warmwater River Warmwater Stream

[a]An "ecological feature" is a natural community or group of natural communities or other significant habitats that occur in close proximity and may be affected by similar natural disturbances or interdependent in some other way. Ecological features were defined as management opportunities because individual natural communities often occur as part of a continuum (e.g., prairie to savanna to woodland, or marsh to meadow to shrub swamp to wet forest) or characteristically occur within a group of interacting community types (e.g., lakes within a forested matrix) that for some purposes can more effectively be planned and managed together rather than as separate entities. This does not imply that management actions for the individual communities or habitats are the same.

[b]See Chapter 7, "Natural Communities, Aquatic Features, and Selected Habitats of Wisconsin," for definitions of natural community types.

found within the ecological landscape are on the "Ecologically Significant Places within the Forest Transition Ecological Landscape" map in Appendix 11.K at the end of this chapter.

Because of the size, geographic scope, disturbed condition, and heterogeneous nature of this ecological landscape from east to west, there is no single ecological opportunity that stands out as especially representative of the Forest Transition as a whole. The ecological management opportunities presented below are indicative of conditions that apply to particular portions of the Forest Transition Ecological Landscape. Additional information of value for those with stewardship responsibilities encompassing large areas in diverse, complex landscapes such as the Forest Transition may be obtained from information taken from the National Hierarchical Framework of Ecological Units (Cleland et al. 1997), particularly at the Subsection and Landtype Association levels.

Extensive Mesic Forests with Embedded Wetlands, Lakes, and Streams

Much of the Forest Transition Ecological Landscape has been deforested since Euro-American settlement, with the most severe forest loss in the central portion of the ecological landscape. Forest remnants in the western parts of the ecological landscape occur as scattered woodlots though some moderately sized forest patches persist there.

The most extensive areas of forest here occur to the east, on the Green Bay Lobe Stagnation Moraine, where mesic forest persists as the matrix community encompassing the western half of the Menominee Indian Reservation and roughly half of Lakewood District in the Chequamegon-Nicolet National Forest. The reservation lands of the Menominee Nation have been managed for timber products for over 150 years, but much of this forest was never clearcut, nor did the severe slash fires that destructively burned so much of the north during the Cutover affect as much of the land within the reservation boundary. The reservation forest is especially notable for retaining many of the structural and compositional features that historically characterized mesic forests north of the Tension Zone. Eastern hemlock and yellow birch remain common in some areas, even in the younger age classes, and a few stands have retained an eastern white pine supercanopy. American beech reaches its westernmost range limits here and in some places is a significant canopy component. The extent and condition of this forest contribute to the high water quality for which the Wolf River, its tributaries, and the reservation lakes and spring ponds are known.

In addition to relatively low fragmentation, the forests of the Menominee Indian Reservation have retained structural and compositional characteristics that are now scarce or absent in many parts of northern Wisconsin. These include large trees, a good representation of eastern hemlock, yellow birch, northern white-cedar, and (to the east) American beech, a multi-layered canopy, large standing snags, coarse woody debris, and tip-ups. Photo by Mike Mossman, Wisconsin DNR.

Outstanding Ecological Opportunities in the Forest Transition Ecological Landscape

- There are extensive mesic forests and forested watersheds in the eastern part of the ecological landscape, which include embedded wetlands, lakes, ponds, and streams.
- Some of the state's major river corridors occur in the Forest Transition Ecological Landscape: St. Croix, Chippewa, Black, Wisconsin, and Wolf rivers.
- Dry-mesic forests of oak or oak mixed with eastern white pine, are common toward the western end of the ecological landscape.
- Wetlands and associated waterbodies including acid peatlands, fens, sedge meadows, marshes, northern white-cedar swamps, marl flats, and marl lakes are important here.
- Bedrock habitats such as glades and cliffs along the St. Croix, Eau Claire, Rib, and Wolf rivers are important natural features in this ecological landscape.
- Important open landscapes such as surrogate grasslands and associated open wetlands occur in the central part of the Forest Transition.
- Miscellaneous opportunities include small streams, spring ponds, spring runs, rich mesic forest remnants, high quality forested and open wetlands, and scattered rare species populations.

Almost all of the U.S. Forest Service lands to the north of the Forest Transition Ecological Landscape had been cut over and burned during the late 19th and early 20th centuries, and these lands are now managed primarily for timber production and, to a lesser extent, for recreation. Nevertheless, these lands constitute a large block of relatively unbroken forest and offer many opportunities to study forest succession and recovery and to compare management impacts on similar vegetation with different land use and disturbance histories, and somewhat different management philosophies.

An area of rugged moraine (part of the Green Bay Stagnation Lobe) occurs on U.S. Forest Service lands in Oconto County where there are a few small old-growth mesic hemlock-hardwood forest remnants that have retained a supercanopy of huge eastern white and red pines. Some of the wetlands and lakes in this part of the ecological landscape are apparently fed by calcareous groundwater, which has favored the growth of several rare ***calciphilic*** plants. Marl is precipitated in several lakes here, and marl flats occur on the margins of some of these lakes.

Management Opportunities, Needs, and Actions

- Partner with the U.S. Forest Service to identify and monitor selected forest resources.
- Do the same with the Menominee Nation.
- Support the continuation of the Nicolet National Forest's annual breeding bird survey.
- Support the continuation of studies on the impacts of white-tailed deer browse on trees, shrubs, and herbs.
- Encourage the maintenance of a high percentage of forest cover throughout the watersheds of this area.
- Identify and clarify those management opportunities in extensive areas of continuous forest cover that cannot be achieved on lands that are more heavily disturbed and severely fragmented.
- Assess the extent and severity of damage to forest soils and understory vegetation due to the activities of exotic earthworms.

River Corridors: Wisconsin, St. Croix, Chippewa, Black, Wolf, Eau Claire, Plover, and Big Rib Rivers

The rivers of the Forest Transition Ecological Landscape support a wealth of aquatic life, including rare fish and invertebrates as well as abundant game fish. The vegetation and geologic features bordering these rivers offer habitats that also support important species. Among the habitats found within the river corridors are marshes, sedge meadows, lowland hardwood forests, conifer swamps, and various upland forest communities. Bedrock features such as cliffs, glades, and river dalles are more locally distributed within the river

Rice Lake and Peaslee Bottoms along the lower St. Croix River. The St. Croix River corridor supports numerous rare species and receives heavy use by migratory birds. Photo by Mike Mossman, Wisconsin DNR.

corridors but provide critically important habitats for some of the more specialized organisms.

One of the potentially important functions for these riparian corridors is to maintain connectivity between sensitive habitats in and along the rivers. The river corridors also serve as connectors between the ecological landscapes of the north and those of the south and may serve as travel and dispersal routes for plants and animals preferring or needing relatively undeveloped areas to accomplish or facilitate their movements.

Because the Forest Transition Ecological Landscape occupies an area that is indeed transitional, between the vast northern forests of the western Great Lakes Region and the much more densely populated and heavily developed lands to the south, protection and appropriate management of these corridors is potentially critical. Tempering the impacts of land uses that can increase surface water temperatures will be essential in light of the forecast impacts of climate change. Many species in these streams are intolerant of high water temperatures and rely on the thermal diversity of these large streams for various life history stages.

Management Opportunities, Needs, and Action

- Continue cooperation with the National Park Service at the St. Croix National Scenic Riverway to monitor the many sensitive aquatic species inhabiting the St. Croix River system, including fish, globally rare mussels, and other invertebrates. If necessary, refine the list of target species whose population trends and other factors lead them to serve as effective indicators of changes in water quality, habitat diversity, and harmful disturbances to the river system.
- Maintain or restore native vegetation where possible on the terraces and bluffs along the St. Croix River and within the river's floodplain. Priorities include continuous bottomland and upland forests but should include important microsites such as seeps, cliffs, and glades along its entire length.
- Work with private landowners along the St. Croix to protect blufflands, forests, and other natural features that adjoin the river but lie outside of the riverway boundary.
- Ensure that the St. Croix Falls Dam is operated as a ***run-of-the-river*** facility to maintain sufficient habitat to maintain viable populations of sensitive fish, mussels, and other invertebrates downstream at all times.
- Develop and apply criteria for identifying opportunities to protect biological diversity-rich reaches of aquatic and riparian habitat on all of the important rivers crossing and/or draining the Forest Transition Ecological Landscape. Develop and implement a plan to provide needed protection of these stream reaches.
- Examine the level of protection for lands (including wetlands) within these river corridors, assess the adequacy of that protection, and develop plans to address shortcomings. The major river corridors of the Forest Transition Ecological Landscape occupy strategically important areas that can or could maintain connectivity between northern and southern Wisconsin.
- Improve the operations of hydroelectric dams on all rivers in the ecological landscape to protect and, where feasible, restore populations of aquatic organisms impacted negatively by habitat fragmentation, unnatural flow variations, and deleterious thermal impacts. This could include but not be limited to rare fish and invertebrates. Ongoing trials of new fish passage devices may prove useful in reinvigorating genetic diversity that has been diminished by the population isolation resulting from impassable dams.
- Remove dams as opportunities arise to improve associated stream habitats where fisheries and aquatic diversity can be improved and where local communities are willing partners.
- As in the rest of the state, maintain good water quality through development and implementation of sound land use plans and practices for watersheds within the ecological landscape. Pay particular attention to the need to address nonpoint issues associated with the high density of farms in the central part of the Forest Transition.
- Encourage agricultural ***best management practices*** in all agricultural areas designated as vulnerable to ground or surface water contamination.
- Better data on the types, distribution, concentrations, and impacts of toxic substances in lakes and river biota may be needed to address past industrial discharges. This information may be useful to collect in conjunction with ***Total Maximum Daily Load*** (TMDL) reviews as they are scheduled.
- Continue to identify and pursue the abandonment of water supply wells that do not meet state standards for prevention of groundwater contamination and that serve as conduits for contamination of groundwater.

- Evaluate impacts to water quality and stream habitat from nonmetallic mining (such as on the Big Rib River). Investigate the utility of nonmetallic mine permit compliance monitoring as a means of addressing any identified problems in the central Wisconsin portion of the Forest Transition Ecological Landscape. Sustain the educational initiative on gravel mining related to the Chapter 30, Wisconsin Statutes, permitting process that is required for excavation and dredging in ***navigable*** waters (WDNR 1992).
- Monitor and evaluate the effectiveness of the winged maple leaf mussel captive breeding program and continue to seek new methods that have the potential to restore the snuffbox and other mussel populations impacted by dams, impaired water quality, loss of host fish, and degraded physical habitat.

Dry-mesic Forests of Oak, Pine, and Mixed Oak-Pine

Dry-mesic forests dominated by northern red oak, white oak, American basswood, and other hardwoods are locally common in the western part of the Forest Transition Ecological Landscape. Some of the larger blocks of more mature forest of this type support interior species, including locally high densities of the Wisconsin Threatened Cerulean Warbler. Some of these forests are composed mostly of plant species characteristic of regions south of the Tension Zone. At least some of the resident animals have more southerly distributions as well.

More localized areas of dry-mesic forest, in which eastern white and red pines are sometimes dominant, occur on areas with shallow soils over bedrock and on some of the coarse-textured, south- or southwest-facing end moraines.

Oak-dominated Southern Dry-mesic Forests occur in the western part of the Forest Transition Ecological Landscape, providing key habitat for plants and animals reaching their northernmost range limits here. Western Polk County. Photo by Eric Epstein, Wisconsin DNR.

Management Opportunities, Needs, and Actions

- Identify and protect existing blocks of older dry-mesic hardwood forests, especially those known to have or with the potential to harbor rare species. Expand and connect such areas where feasible and appropriate.
- Public lands are not extensive in the western part of the ecological landscape away from the St. Croix River. Assess the opportunities to protect additional lands and water in the western part of the ecological landscape via various public-private partnerships.
- Additional field inventory of dry-mesic forests is needed in areas such as Polk and Barron counties to better characterize and identify the largest and least disturbed areas of dry-mesic forest and document the presence and status of associated sensitive species.
- Ensure that management plans for public lands in the Forest Transition Ecological Landscape protect the sensitive resources they contain and do not overwhelm them with incompatible development.
- Protect undeveloped lakes, ponds, and streams that co-occur with these dry-mesic forests.
- Determine the role of fire in creating and maintaining these forests. Determine how fragmentation, fire suppression, grazing, and other departures from past natural disturbance regimes and landscape conditions have altered them.
- Examine the original federal public land notes and the Bordner surveys (WDA 1930–1947) for this part of the ecological landscape and describe and clarify the nature of the vegetation prior and subsequent to the Cutover and Euro-American settlement.
- Document in detail the composition and structure of these forests. A number of forest plants and animals appear to be at or close to their northern range limits here. It may be especially useful to have good records of these ranges given ongoing environmental changes.

Wetlands and Waterbodies: Conifer Swamps, Northern Fens, Sedge Meadows, Marshes, Springs, and Marl Flats

Wetlands are locally common in parts of the Forest Transition Ecological Landscape, such as along the southern margins of the end moraines in the adjacent ecological landscape to the north (the North Central Forest). Extensive wetlands occur along the northern edge of the Forest Transition, adjacent to moraines at the margins of the Langlade, Wisconsin Valley, and Chippewa lobes.

Important wetland communities in this ecological landscape include wet conifer swamps dominated by black spruce or tamarack on acid peat, wet-mesic northern white-cedar-dominated conifer swamps in areas receiving calcareous groundwater seepage, hardwood swamps, floodplain forests along several of the large rivers, sedge meadows, northern fens; shrub swamps, and emergent marshes.

Among these wetlands, natural communities in need of additional conservation efforts include fens, sedge meadows, acid conifer swamps, and northern white-cedar swamps.

Ephemeral Ponds are extremely important features that have often been overlooked in developing protection priorities. Their protection is among the landscape level priorities, along with the upland forests they are usually embedded within.

Alkaline wetlands and waterbodies occur at a few locations in the eastern part of the ecological landscape. These are likely influenced by calcareous material found in the Green Bay Lobe Stagnation Moraine. Wetlands and waterbodies indicative of mineral (calcium) enriched groundwater are present, and these entities include northern white-cedar swamps, northern rich fens, marl flats, and marl lakes. There is relatively high potential in such habitats for the occurrence of certain rare plants and other organisms with high calcium requirements or tolerances.

Isolation of wetlands is common in some parts of the Forest Transition, especially in the central portion of the ecological landscape, where agriculture is the dominant land use. Habitat isolation is also significant in the westernmost areas. Impacts of the deforestation of surrounding areas, grazing, added nutrient and chemical inputs from field runoff, and the spread of invasive species such as reed canary grass and purple loosestrife need to be better clarified. It is important to establish protection priorities and management needs when assessing site viability in such areas.

Management Opportunities, Needs, and Actions

- Assess the adequacy of existing ecological inventory information for wetlands found along the northern edge of the Forest Transition and adjoining the end moraines in the central and eastern parts of this ecological landscape. Respond appropriately.
- Assess protection levels for calcareous wetlands in and around the Green Bay Lobe Stagnation Moraine within and outside of the Chequamegon-Nicolet National Forest.
- Examine rare plant records and air photos and design future surveys in areas with high potential for harboring species of interest that include public and, where permission has been granted by the owners, private lands.
- Using wetland maps, satellite imagery, and air photos, identify large hydrologically intact wetland complexes that have high potential to support good examples of declining natural communities and other important habitats, and the sensitive species that depend on them.
- Develop priorities for protection, especially when lakes, streams, or other characteristic landscape features are nearby.
- Restoration activities need to be defined and prioritized. Unlike areas to the south, some wetlands in the Forest Transition remain in good condition and are hydrologically intact. Unlike most ecological landscapes farther north, many wetlands here have been degraded by past land uses and land use changes such as the replacement of forest by lands dedicated to agricultural use.

Bedrock Habitats

Bedrock exposures are highly localized in this ecological landscape. Overall they are uncommon. Most outcroppings occur as cliffs, talus slopes, bedrock glades, river dalles, or rapids. Extensive basalt cliffs occur along the St. Croix River near St. Croix Falls, and these provide suitable conditions for some of the more extensive pine forests in the Forest Transition. The cliffs and ledges also provide habitat for several highly specialized plant species.

The dalles of the Eau Claire River in Marathon County features exposures of metamorphosed rhyolite (Dott and Attig 2004). Granite exposures along the Wolf River as it crosses the Menominee Indian Reservation and parts of Langlade County create series of ecologically important rapids and potentially significant streamside habitats. Rib Mountain is

Semi-open glade community on basalt bedrock features sparse cover of stunted oaks, prairie grasses, mosses, lichens, and ferns. Western Polk County. Photo by Eric Epstein, Wisconsin DNR.

one of several significant bedrock features just west of the Wisconsin River near Wausau. Quartzite glades, talus slopes, low cliffs, and spring seeps occur there.

Management Opportunities, Needs, and Actions

- Assess the need for survey work on bedrock habitats and identify priority sites and important taxa.
- Several kinds of development pressure east of the St. Croix River may threaten bedrock habitats (e.g., quarrying), so there is some urgency in doing this soon.
- Invertebrates and nonvascular plants are among the neglected taxa that may warrant additional survey work on the bedrock habitats.
- Characterize bedrock vegetation at sites such as the St. Croix River dalles, Interstate State Park Bedrock Glades, Rib Mountain, and the Eau Claire River dalles and devise a plan to periodically monitor the vegetation and selected species.
- Work with the Menominee Nation to better assess the ecological significance of bedrock exposures along the Wolf River.

Surrogate Grasslands, Open Habitats

This opportunity is meant to capture large sites that are or could be managed to provide extensive open habitats for rare or declining grassland birds, including the Wisconsin Threatened Greater Prairie-Chicken. Large areas of upland grass adjacent to open wetlands such as sedge meadow and/or emergent marsh may be the most effective places to manage as native upland grass habitats are scarce or absent from most of this formerly forested ecological landscape.

Opportunities to manage for upland grasslands in this ecological landscape need to be carefully weighed against opportunities in other ecological landscapes. The Central Sand Hills, Central Sand Plains, Southeast Glacial Plains, Southwest Savanna, Western Coulees and Ridges, and Western Prairie ecological landscapes also contain extensive areas of surrogate grassland, but these areas harbor remnant prairies and savannas (historically, these communities were common there) and support many rare grassland species that do not occur in the Forest Transition Ecological Landscape.

This treeless landscape of open wetlands and surrogate grasslands at George W. Mead State Wildlife Area supports populations of many declining grassland birds. Marathon and Portge counties. Photo by Brian Peters, Wisconsin DNR.

Management Opportunities, Needs, and Actions

- Maintain existing grassland and other associated open habitats for sensitive grassland birds if appropriate and viable.
- Connect or enlarge these sites where feasible where such actions do not divert resources from more viable and highly threatened native grasslands or conflict with opportunities to reduce negative fragmentation and edge impacts to forests.
- Assess the agricultural trends here with respect to biofuel potential and CRP acreage.
- Clarify which species and habitats will benefit most from grassland management, especially at larger scales, and determine where in the Forest Transition these benefits are likely to be greatest.

Miscellaneous Opportunities: Floristically Rich Mesic Forests, Pine Forests, Lakes, Ephemeral Ponds, Spring Ponds, Spring Runs, and Headwaters Streams

The opportunities grouped here include scattered features that are not captured adequately in the categories discussed above. Fragmentation is severe in the central part of the Forest Transition and more moderate but still significant to the west and in the southeast. Public lands in these areas are not extensive but include important state wildlife, fishery, and natural areas (see Appendix 11.G). Several county parks are based on the presence of natural features that are among the best remaining examples of their respective types. Lakes and ponds are locally common, and there may be opportunities in those areas to protect waterbodies and associated habitats that are not yet developed.

Management Opportunities, Needs, and Actions

- Additional inventory work is needed to identify good quality remnant forests, especially of types that are under-represented on protected public lands. Examples include rich mesic hardwood forests, older stands of northern red oak-white oak, and mixed forest of eastern white pine and oak.
- Develop working relationships with NGOs such as local land trusts and assist them in evaluating, prioritizing, and selecting potential conservation projects.
- Protect floristically rich northern white-cedar swamps, especially stands that include areas of groundwater seepage,

springs runs, streams, and spring ponds. Stands that can be protected from white-tailed deer damage are the highest priority, but because white-tailed deer densities are high throughout so much of this ecological landscape, using only that criterion would eliminate virtually all browse-sensitive vegetation.

- Evaluate the ecological significance of the numerous lakes in the southeastern part of the ecological landscape. This will require field inventory, including work designed and conducted by invertebrate and aquatic plant specialists.
- Devise a survey methodology that will enable the identification of ephemeral ponds and develop a means of prioritizing their protection. Develop guidelines for managers of sites containing ephemeral ponds.
- Continue to promote the Wild Lakes program to preserve lakes in the St. Croix River basin, Polk, Barron and Washburn counties, southern Langlade County, and northern Oconto County, evaluating candidate lakes and protecting them via gift, Stewardship Program acquisition, NGO partnerships, or other means (WDNR 1997).
- Identify and protect critical spawning, reproductive, and nursery habitat for selected game and ***nongame*** fish species for which this ecological landscape offers good management opportunities.

Socioeconomic Characteristics

Socioeconomic information is summarized within county boundaries that approximate ecological landscapes unless specifically noted as being based on other factors. Economic data are available only on a political unit basis, generally with counties as the smallest unit. Demographic data are presented on a county approximation basis as well since they are often closely associated with economic data. The multi-county area used for the approximation of the Forest Transition Ecological Landscape is called the Forest Transition counties. The counties included are Barron, Chippewa, Clark, Langlade, Lincoln, Marathon, Menominee, Polk, Portage, Shawano, Taylor, Washburn, Waupaca, and Wood because at least 25% of each county lies within the ecological landscape boundary (Figure 11.11).

Figure 11.11. *Forest Transition counties.*

History of Human Settlement and Resource Use

American Indian Settlement

The archaeology of northern Wisconsin is fragmentary and often poorly understood. Given this, there are many gaps in our understanding of the cultural evolution of early peoples in northern Wisconsin. It can be generally said that technology and traditions occurred earlier in southern Wisconsin than in northern Wisconsin (see Chapter 2, "Assessment of Current Conditions," for a description of the cultural traditions of Wisconsin). Although sporadic, there is evidence of habitation in the Forest Transition Ecological Landscape as far back as the Late Paleo-Indian Phase (7,000 to 8,000 years ago) at the Interstate Park site in Polk County, where there is evidence of hunting of a now extinct species of bison (*Bison occidentalis*) (Palmer 1954, Mason 1997).

There is little archaeological evidence of great significance in the Forest Transition during the time of the Archaic Tradition but enough to say that this ecological landscape was occupied during this time. There is more evidence of occupation by the time of the Woodland Tradition, with evidence of woodland habitation at the Little Eau Plaine Site in Marathon County and effigy mound groups at Cyrus Thomas in Barron County as well as other effigy mounds on the southern fringes of the Ecological Landscape (Stevenson et al. 1997).

An area of great archaeological interest is the pipestone deposits in Barron County. Pipestone is a fine-grained sedimentary rock that is reddish to brownish in color and when first exposed is quite soft and easy to shape by scraping, drilling, or grinding. After exposure, pipestone hardens and becomes harder to work. Pipestone was quarried for various uses including, as the name would imply, pipes because of the ease with which holes could be drilled to form the stem of the pipe. It was also used for other purposes such as beads, tubes, pendants, and other ornamental uses (Behm 1997). Fairly simple pipes and other artifacts made of pipestone began to appear during the middle Woodland period (about 2,000 years ago) and continued to become more elaborate all the way to the time of Euro-American contact.

At the time just prior to Euro-American contact, the Santee Dakota likely claimed much of what are now the western and northern portions of the Forest Transition Ecological

Landscape, while the Menominee inhabited parts of the eastern portion, along with the Winnebago (Ho-Chunk) (Mason 1988). The Ojibwe tribe, or "puckered moccasin people," migrated south from what is now Michigan's Upper Peninsula along rivers near the end of the 17th century (The Wisconsin Cartographer's Guild 1998). In doing so, they gradually displaced the Santee Dakota people, who then moved farther west and eventually out of Wisconsin.

Euro-American Contact and Settlement

French fur traders, missionaries, and soldiers began arriving in the region during the mid-17th century. These early Europeans made contact with the American Indian tribes and subsequently set up trading posts, missions, and forts along lakes and rivers used as travel routes. By 1820 hunting and trapping in northern Wisconsin had depleted the wildlife resource, and the fur trade moved farther north into Canada. Soon after, the Menominee ceded large sections of land to the U.S. Government. In 1854 the tribe was "awarded" their current reservation, which is also the current day Menominee County and lies partly within the Forest Transition Ecological Landscape. In 1856, after two decades of negotiations, the Stockbridge and Munsee Bands moved onto land obtained from the Menominee in Shawano County, adjacent to the Menominee Reservation (see Chapter 2, "Assessment of Current Conditions," for information about the ***Ceded Territory*** and the Menominee and Stockbridge Munsee).

The 1840 federal census estimated only 1,623 Euro-Americans in Portage County (ICPSR 2007). By 1850 Portage County's population had actually shrunk (1,250), while Chippewa and Marathon counties were the only other Forest Transition counties with a reported permanent population. Permanent Euro-American settlement began in earnest in the 1850s. By 1870 a considerable number of Norwegian settlers resided in this region of the state, mainly in the area from Crawford to Barron counties (The Wisconsin Cartographer's Guild 1998). Swedes began immigrating to the region during the 1860s and settled mainly in the northern region of the state, particularly in Burnett and Polk counties. Icelandic settlements also began to appear, particularly near Pulcifer in Shawano County. The early settlement groups, Norwegian, Swedish, and Icelandic, along with scattered populations of Croatian, Slovene, Czech, Dutch, French, Italian, Polish, and Russian immigrants, contributed to the subsequent agricultural growth of the region.

Early Agriculture

In 1850 there were reportedly only 12 farms in the Forest Transition counties (ICPSR 2007). By 1860 the number of farms in the Forest Transition counties had grown to 1,970 while the human population had reached 26,601. The population more than doubled in each of the subsequent decades, while farm numbers grew even more quickly. Farm numbers continued to grow in the Forest Transition counties, reaching 44,622 farms in 1920, which represented nearly a quarter of all farms in the state (Figure 11.12). Farm numbers in the Forest Transition counties decreased during the 1930s following the onset of the Great Depression, which drove some marginal farms out of production. However, farm numbers in the Forest Transition counties increased by 1940 to 45,678. Meanwhile, the population in the Forest Transition counties continued to grow throughout this time period.

Following World War II, farm numbers again began to decline as mechanization and small farm consolidation combined to increase the average size of farms (Figure 11.13). That trend continued throughout much of the remaining 20th century. Farms tended to be slightly smaller on average in the Forest Transition counties than in the state as a whole, until the Forest Transition counties' farm size equaled the state average in 1950, averaging 139 acres compared to 138 acres statewide (ICPSR 2007).

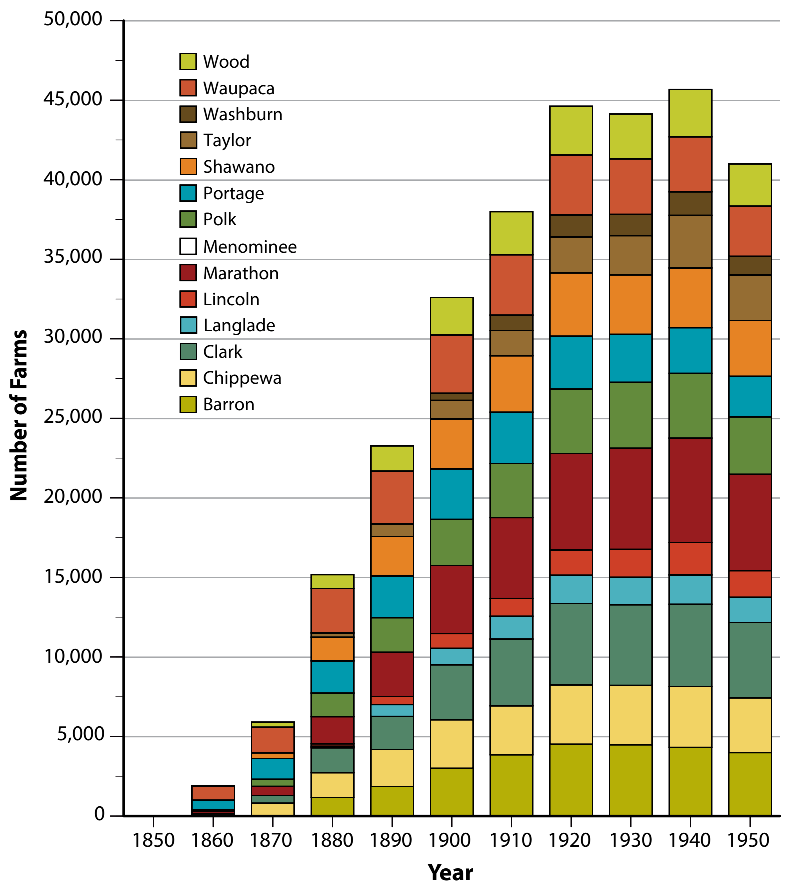


Figure 11.12. *Number of farms in Forest Transition counties between 1860 and 1950 (ICPSR 2007).*

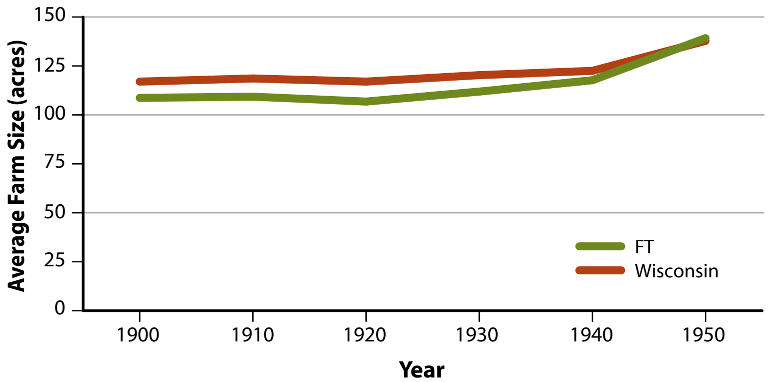


Figure 11.13. *Average farm size in Forest Transition counties between 1900 and 1950 (ICPSR 2007).*

Total value of all crops indicates the extreme influence of the Great Depression on agriculture. In 1910 all crops harvested in the Forest Transition counties had an estimated total value of $22.6 million, which nearly quadrupled by 1920 ($89.2 million) (ICPSR 2007). However, total value of all crops in the Forest Transition counties plummeted in 1930 ($45.7 million) and fell further in 1940 ($30.6 million). Total values of crops in the Forest Transition counties comprised only 18.2% of total crop value in the state in 1940, even though these crops came from farms comprising 24.6% of all Wisconsin farm acreage. Farms in the Forest Transition counties historically have not been as productive as the state as a whole, in part due to less fertile soils, cooler climate, and shorter growing seasons than counties to the south.

Over the early part of the 20th century, the type of farming in the Forest Transition counties underwent some fundamental shifts as Wisconsin became established as a leader in the dairy industry. The 1910 agricultural census listed "cereals" as 35.4% of the total value of all crops harvested in the Forest Transition counties, but cereals comprised as little as 23.4% of total crop values in 1930, recovering only to 25.7% by 1940 (ICPSR 2007). Meanwhile, "hay and forage," associated with livestock farming, was 35.8% of total value of crops harvested in the Forest Transition counties in 1910 and had risen to 52.9% of total crop value by 1940. In Taylor (71%), Lincoln (65.8%), and Clark (63.1%) counties, hay and forage was an especially high proportion of their total crop value in 1940.

Early Mining

Mining has occurred in Wisconsin for thousands of years, and there is some evidence to suggest this activity began during Paleo-Indian times. However, mining was not a major endeavor historically in the Forest Transition Ecological Landscape.

Early Transportation and Access

In the early 19th century, a network of trails connected the many American Indian villages throughout the Wisconsin portion of what was then Michigan Territory. Due to rapid Euro-American settlement in the lead mining district in southwestern Wisconsin and along the Lake Michigan shoreline, these trails were widened into roads suitable for ox carts and wagons (Davis 1947). A system of military roads was developed in southern Wisconsin around the same time, connecting key cities and forts with one another. In the late 1860s, a military road was completed through northeastern Wisconsin from Green Bay to the Lake Superior area near Ontonagon that crossed the Forest Transition Ecological Landscape. A second military road was also completed during this time from Wausau to Lake Superior near Ontonagon, which also crossed this ecological landscape. By 1870, however, the importance of railroads had caused these relatively primitive roadways to become of secondary value.

The Chicago and North Western Rail Line (the "Omaha Road") dissected the westernmost region of the Forest Transition Ecological Landscape, running from Superior in the northwestern corner of the state, south to Chippewa Falls (Fisher 1937). The Soo Line also ran through this region of Wisconsin, connecting the Superior area with Spencer in Marathon County. The Milwaukee Road (or its predecessors) had a line that ran up the Wisconsin River valley and crossed the Forest Transition. There were also many independent rail lines operated by logging companies during the lumbering boom of the late 1800s and early 1900s.

See the "Statewide Socioeconomic Assessments" section in Chapter 2, "Assessment of Current Conditions," for further discussion of the history of transportation in Wisconsin.

Early Logging Era

Sawmills were first built along rivers in areas containing large stands of timber. Where the rivers made it difficult to float logs, lumbermen built mills as close to the cutting area as possible, while on easier rivers, sawmills were generally more centralized (Ostergren and Vale 1997). The continual westward surge of the agricultural frontier by Euro-Americans to treeless lands in the western part of the country increased the demand for lumber from northern Wisconsin. Wisconsin also had the advantage of an extensive network of waterways flowing south from the northern timber region. Wisconsin lumber production reached its annual peak at more than 3 billion ***board feet*** cut in 1892 (The Wisconsin Cartographer's Guild 1998). The Forest Transition region of the state hosted a number of early saw mills, including mills at the present-day towns of Merrill, Mosinee, Wisconsin Rapids, Wausau, and Chippewa Falls (Ostergren and Vale 1997).

Roth (1898) surveyed forest conditions in some northern Wisconsin counties at the close of the 19th century. Large tracts of nearly every part of Barron County had been cut over and burned, leaving isolated remnants of pineries, and heavily culled hardwoods damaged by fire. Roth (1898) estimated standing volume of pine at 150 million board feet, while "better hardwoods" stands comprised an estimated 250 million board feet. Dominant hardwood species were oak, American basswood, birch (*Betula* spp.), and maples, in relatively equal proportions. (Waupaca County was not part of Roth's survey, and present-day Menominee County was not a county at the time of Roth's survey.) By comparison, today there are an estimated 188 million board feet of pine and 545 million board feet of hardwood ***sawtimber*** in Barron County forests (USFS 2009).

In Chippewa County, the pine had largely been cut, especially along streams, leaving isolated patches comprising an estimated 500 million board feet (Roth 1898). The extensive swamps in the northeast were fire damaged and poorly stocked. Fire damage in the wake of the Cutover had also damaged both hardwood and eastern hemlock stands. Eastern hemlock had not been heavily harvested, and its volume was an estimated 800 million board feet, with a yield of 5,000 board feet per acre that exceeded hardwood yields. Oak was the predominant hardwood species in the Forest Transition Ecological Landscape portion of Chippewa County but comprised only 10% of total hardwood volume (1.1 billion board feet) county-wide. By comparison, today there are 155 million board feet of pine, 25 million board feet of eastern hemlock, and 557 million board feet of hardwood sawtimber in Chippewa County forests (USFS 2009).

A group of men standing amidst a huge log jam on the St. Croix River. The men are standing in a line holding a rope. A bridge spans the river in the far background. Photo courtesy of the Wisconsin Historical Society, Image ID WHi-62818.

A lumber mill on the Wisconsin River in Marathon County, around 1900. Photo from Wisconsin DNR archive.

Roth (1898) noted that Clark County was largely covered by level loam soils (except the part in the Central Sand Plains), which were formerly covered by hardwoods and impressively dense and large eastern white pine. Eastern hemlock was only found in the northeastern corner of the county. Roth estimated the remnant pine stands at only 200 million board feet after being largely cut over and replaced by settlement. Hardwoods, especially oak, had been culled to a remaining stand of about 650 million board feet. Oak comprised 30% of the standing hardwoods, with the balance being largely American basswood and elm. Most of the county remained covered by culled hardwoods, much of it fire damaged. Clark County's vast pinery had largely disappeared in the wake of the Cutover, which left "tracts of bare waste many miles in extent" (Roth 1898). By comparison, today there are 286 million board feet of pine and 757 million board feet of hardwood sawtimber in Clark County forests (USFS 2009).

Roth (1898) described expansive mixed hardwood and eastern hemlock forests in Langlade County, interspersed with patches and belts of pine. The pine, however, had been largely cut over and totaled only 150 million board feet of standing timber. Largely untouched by harvests or fire, the Langlade County hardwood forests remained well stocked, with an estimated 1 billion board feet of eastern hemlock and 1.1 billion board feet of hardwoods. In equal parts, birch, American basswood, and elm were about 80% of all hardwoods, while maple and ash species comprised a smaller hardwood component. By comparison, today there are 107 million board feet of pine, 41 million board feet of eastern hemlock, and nearly 1.1 billion board feet of hardwood sawtimber in Langlade County forests (USFS 2009).

Roth (1898) noted that 80% of Lincoln County was covered by mixed sand and clay soils supporting mixed forests of pine, eastern hemlock, and hardwoods. Pine was the principle cover type on the sandier soils. Pine had largely been cut over, leaving an estimated 250 million board feet standing. Largely untouched by harvests or fire, the Lincoln County hardwood forests remained well stocked, with an estimated 1 billion board feet each of eastern hemlock and hardwoods. Birch, American basswood, and elm were the principle hardwood species, comprising about 70% of all standing hardwood volume. Dominated by northern white-cedar and tamarack, many of the swamps were either harvested or damaged by fires spilling over from cut-over pine lands. According to Roth, these cut-over areas totaled thousands of acres of now bare terrain, unsuitable for agriculture. By comparison, today there are 312 million board feet of pine, 25 million board feet of eastern hemlock, and 577 million board feet of hardwood sawtimber in Lincoln County forests (USFS 2009).

The pine in Marathon County was reported to be heavily cut (Roth 1898), leaving an estimated 250 million board feet, scattered sporadically among the county's mixed hardwoods and eastern hemlock forests. Eastern white and red pine stands were regenerating, especially along the Wisconsin River. With other lands more suitable for agriculture plentiful, much of Marathon County's cut-over pine land remained barren waste in the wake of post-Cutover fires. Roth reported heavy harvests of hardwoods and eastern hemlock in the 1880s, but with an estimated remaining stand of 1.5 billion board feet for both hardwoods and eastern hemlock. Birch and American basswood were each estimated to comprise 30% of all hardwoods, elm was estimated at 20%, and oak at only 5%. By comparison, today there are 124 million board feet of pine, 104 million board feet of eastern hemlock, and nearly 1.1 billion board feet of hardwood sawtimber in the forests of Marathon County (USFS 2009).

Polk County's pinery was reported by Roth (1898) to be largely cut over by the 1890s, with the remaining standing timber in isolated patches totaling 240 million board feet. Hardwoods, too, had been extensively harvested, with the majority of the remaining stand (estimated at 600 million board feet) occurring in northern Polk County. Oak and American basswood were the principle hardwood species. Jack pine stands to the northwest were extensive, though largely uncut at the time of Roth's survey (note that virtually all of the jack pine, and probably some of the other species mentioned here, occurred in the adjacent Northwest Sands Ecological Landscape). Roth also noted "fair-sized Poplar" thriving on Polk County's sandy loam, whereas in much of the state this species went unnoticed (Roth 1898). By comparison, today there are 84 million board feet of pine, 35 million board feet of jack pine, and 809 million board feet of hardwood sawtimber in Polk County forests (USFS 2009).

Roth (1898) reported heavy cutting of pine and hardwoods in most of Portage County's forests, leaving expansive tracts of burned-over pine and hardwood slash. Only 20 million board feet of pine were estimated to remain standing in isolated small pockets. Mixed hardwoods and eastern hemlock stands totaled about 150 million board feet, about 50 million of which was eastern hemlock. Yet to be harvested, jack pine forests were extensive and heavily stocked, especially in southwest Portage County (mostly in the Central Sand Plains Ecological Landscape). Jack pine standing timber was estimated at 150 million board feet. By comparison, today there are 397 million board feet of red and eastern white pine, only 11 million board feet of eastern hemlock, 355 million board feet of hardwoods, and only 25 million board feet of jack pine sawtimber in Portage County forests (USFS 2009).

At the time of Roth's survey, the northwestern two-thirds of Shawano County was a mix of eastern hemlock, hardwoods, and pine (Roth 1898). The pine was almost all cut by 1897. Roth estimated that 650 million board feet of eastern hemlock and 700 million board feet of hardwoods (primarily American basswood, elm, and maple) remained. Bare "stump prairies" occurred in all parts of the county. Today there are 247 million board feet of pine, 60 million board feet of eastern hemlock, and 656 million board feet of hardwood sawtimber in Shawano County (USFS 2009).

Taylor County was once covered by a continuous mixed forest, but at the time of Roth's survey, the pine had been largely cut, leaving small patches in the southwest totaling an estimated 200 million board feet (Roth 1898). Nonetheless, 60% of Taylor County's wild lands remained under forest cover, and it was relatively unscathed by forest fire. Eastern hemlock remained a prevalent species in the remaining forests, with estimates of stand volume ranging from 1.5 to 2 billion board feet. Hardwood volumes were estimated at 1 billion board feet, predominantly American basswood and birch. Swamps in Taylor County were stocked with tamarack, especially, along with northern white-cedar and spruce (*Picea* spp.; most of this would have been black spruce. By comparison, today there are 134 million board feet of pine, 105 million board feet of eastern hemlock, and 767 million board feet of hardwood sawtimber in Taylor County forests (USFS 2009).

Washburn County was largely covered in pine prior to the Cutover (similar to the situation in Polk County, most of the Washburn County pinery was in the Northwest Sands Ecological Landscape), but only 350 million board feet of pine remained at the time of Roth's survey (Roth 1898). According to Roth's observations, "some of the largest areas of perfectly bare, cut and burned-over lands in Wisconsin, occur in this [Washburn] County." Only 220 million board feet of hardwoods were estimated, with large areas devoid of merchantable timber. Together, nearly equal parts of American basswood, maple, oak, and birch made up 80% of all hardwood volume. By comparison, today there are 265 million board feet of pine and 683 million board feet of hardwood sawtimber in Washburn County forests (USFS 2009).

Wood County had been heavily cut over by the time of Roth's survey, and eastern white pine regeneration was already occurring (Roth 1898). Only an estimated 100 million board feet of pine remained in a county that had once been heavily stocked with eastern white pine in the north, and covered in mixed pines to the south. Hardwoods had similarly been heavily harvested, with a remaining estimated stand volume of 300 million board feet on not more than 12% of the land area. More than half of Wood County hardwood volume was oak and American basswood. Eastern hemlock stands occurred only sporadically in the northern portion of the county, associated with the Forest Transition Ecological Landscape. Eastern hemlock volume was estimated at only 50 million board feet. By comparison, today there are 236 million board feet of pine, only 2 million board feet of eastern hemlock, and 664 million board feet of hardwood sawtimber in Wood County forests (USFS 2009).

Resource Characterization and Use[3]

The Forest Transition Ecological Landscape is a fairly large ecological landscape, with 7,100 square miles of land and a large acreage in lakes and reservoirs. The population density of 51 people per square mile is about half the average population density for the state. There is less public land in the Forest Transition Ecological Landscape than elsewhere in the state. The density of hiking and biking trails is low as is the density of campgrounds. However, the amount of ATV and snowmobile trails is very high, as are the numbers of fishing and hunting license sales.

The economy of the Forest Transition Ecological Landscape depends both on agriculture and forestry, although it is not a major producer in either sector. Although the income per acre from farming is about average, the 14 counties rank quite high in dairy and corn production. In the forestry sector, the volume of ***growing stock*** is very high, as is the amount of timber harvested, especially maple, northern red oak, and aspen. The Forest Transition Ecological Landscape ranks third among all ecological landscapes in the state in terms of growing stock volume, volume per acre, and percentage of volume harvested. The major forest type groups are maple-basswood, aspen-birch, and oak-hickory. Timberland acreage has increased statewide over the last 20 years but has remained relatively unchanged in this ecological landscape.

The transportation system of this ecological landscape is somewhat less developed than in the state as a whole, with 14 airports and no cargo ports. The Forest Transition Ecological Landscape has the potential to produce a significant amount of renewable energy, especially woody biomass, corn-based ethanol, and hydroelectric. Currently there is one ethanol plant but no wind facilities.

The Land

Of the 4.54 million acres of land that make up the Forest Transition Ecological Landscape, 44% is forested (USFS 2009). About 88% of all forested land is privately owned while 8% belongs to the state, counties, or municipalities, and 4% is federally owned.

Minerals

Of the 14 Forest Transition counties, five counties are engaged in some type of mineral extraction (WDWD 2009). Marathon County is involved in the production of nonmetallic minerals. In 2007 there were 21 mining establishments in the Forest Transition counties. Due to limited participation in mining, employment and earnings information is not disclosed, and much of this information is limited to summary data. Only Marathon County has full disclosure of mining revenues.

Quartzite quarry, west end of Rib Mountain, Marathon County. Photo by Eric Epstein, Wisconsin DNR.

Frac sand mining is increasing dramatically in some areas of Wisconsin due to the increased use in oil and gas extraction. As of December 2011, there were seven frac sand mining or processing plants active or in development in the Forest Transition counties.

Water (Ground and Surface)

Water Supply

The data in this section are based on the Wisconsin DNR's 24K Hydrography Geodatabase (WDNR 2015c), which are the same as the data reported in the "Hydrology" section of this chapter. However, the data are categorized differently here so the numbers will differ slightly. There are 115,430 acres of surface water, or 2.5% of the total area of the Forest Transition Ecological Landscape. The 3,377 lakes that are at least one acre in size total 70,250 acres, or 61% of total surface water area. There are 24 lakes over 500 acres and 16 that are over 1,000 acres in size. The Big Eau Pleine, Lake Wissota, Lake DuBay, and Long Lake are all over 3,000 acres (the first three of these are impoundments). There are 45,180 acres of streams and rivers and impoundments associated with streams and rivers. The Wisconsin, Chippewa, Black, and Big Eau Pleine rivers are the largest in the Forest Transition Ecological Landscape.

Water Use

Each day 773 million gallons of ground and surface water are withdrawn in the 14 Forest Transition counties (Table 11.3). About 67% of the withdrawals are from surface water. Of the 649,922 people that reside in these counties, 50% are served by public water sources and 50% are served by ***private wells*** (USGS 2010). Marathon and Wood counties account for 97% of water usage for thermoelectric power. The counties with the largest water usage are Wood County (35%) and Marathon County, (30%). Thermoelectric power generation, industry, and irrigation withdrawals account for 39%, 27%, and 19%, respectively, of water usage.

[3]When statistics are based on geophysical boundaries (using GIS mapping), the name of the ecological landscape is followed by the term "ecological landscape." When statistics are based on county delineation, the name of the ecological landscape is followed by the term "counties."

Table 11.3. *Water use (millions of gallons/day) in the Forest Transition counties.*

County	Ground-water	Surface water	Public supply	Domestic[a]	Agriculture[b]	Irrigation	Industrial	Mining	Thermo-electric	Total
Barron	19.1	0.5	4.4	1.2	1.6	10.4	1.8	0.3	–	20
Chippewa	11.6	4.3	5.7	0.6	1.8	3.3	4.0	0.6	–	16
Clark	5.5	1.0	1.4	0.9	3.2	0.5	0.2	0.4	–	7
Langlade	20.6	14.2	1.2	0.5	17.1	15.3	0.2	0.5	–	35
Lincoln	2.9	9.6	1.3	0.8	0.3	0.5	8.1	0.1	1	12
Marathon	24.1	208.8	13.1	2.2	3.5	6.6	42.6	0.8	164	233
Menominee	0.8	0.4	0.3	0.1	0.8	–	–	–	–	1
Polk	11.0	0.5	2.4	1.1	5.9	1.2	0.4	0.7	–	12
Portage	116.9	22.2	9.9	1.7	1.3	92.5	26.2	0.6	7	139
Shawano	2.3	0.5	0.5	0.7	0.9	0.6	0.1	0.0	–	3
Taylor	2.6	0.7	0.6	0.6	0.9	0.2	0.0	0.9	–	3
Washburn	3.4	1.2	0.8	0.6	1.4	1.7	0.1	0.0	–	5
Waupaca	17.6	1.7	5.8	1.6	1.3	8.7	1.7	0.3	–	19
Wood	14.6	254.2	5.7	1.7	1.1	6.1	124.0	0.2	130	269
Total	**253.0**	**519.8**	**53.1**	**14.3**	**41.1**	**147.6**	**209.4**	**5.4**	**302**	**774**
Percent of total	**33%**	**67%**	**7%**	**2%**	**5%**	**19%**	**27%**	**1%**	**39%**	

Source: Based on 2005 data from the U.S. Geological Survey on water uses in Wisconsin counties (USGS 2010).
[a]Domestic self-supply wells.
[b]Includes aquaculture and water for livestock.

Recreation

Recreation Resources

Land use and land cover partly determine the types of recreation that are available to the public. For instance, in the Forest Transition Ecological Landscape, there is more grassland compared to the rest of the state, but it is mostly in the central part of the ecological landscape (see Chapter 3, "Comparison of Ecological Landscapes," and/or the map "WISCLAND Land Cover (1992) of the Forest Transition Ecological Landscape" in Appendix 11.K). Forestland here covers 2 million acres, or 12.3% of the total forested acreage in the state (USFS 2009). There is less public land and a lower density of campgrounds than in the rest of the state (Wisconsin DNR unpublished data). The density of ATV and snowmobile trails, however, is quite high compared to other ecological landscapes, and the number of hunting and fishing licenses sold is second highest in the state (out of 16 ecological landscapes). Acreage in natural areas is much lower than average. There are many Land Legacy sites in this ecological landscape but few with significant recreation potential.

Supply

Land and Waters. The Forest Transition Ecological Landscape comprises 13.1% of Wisconsin's total land area but only 9% of the state's acreage in water. Surface water comprises 2.4% of the total area of the ecological landscape. Streams and rivers make up 16% of the surface water area of the Forest Transition and lakes and reservoirs make up over 83% (WDNR 2015c). The major rivers are the Wisconsin, Chippewa, Black, and Big Eau Pleine. The largest lakes (including several impoundments) are Lake Wissota, Lake DuBay, Long Lake, Shell Lake, Lake Chetac, and Red Cedar Lake.

Public Land. Public access to recreational lands and waters is vital to all types of recreational activity. In the Forest Transition Ecological Landscape, about 433,600 acres, or 9.3% of all land, is publicly owned (WDNR 2005a). This is significantly less than the statewide average of 19.5% and ranks this ecological landscape ninth out of 16 ecological landscapes in the proportion of public ownership. There are about 116,200 acres of state recreational lands, 84,370 acres of federal lands, and 118,100 acres of county lands.

State-owned lands and facilities are especially important to recreation in the Forest Transition Ecological Landscape.

To anglers, the Wolf River, including the segment that flows through the Forest Transition Ecological Landscape, is one of Wisconsin's most revered streams. Langlade County. Photo by John Gremmer.

There are around 3,100 acres of state forest, 5,700 acres in state parks here, including Rib Mountain, Interstate, Lake Wissota, Hartman Creek, and Council Grounds State Parks (WDNR 2005a). In addition, there are 1,900 acres of state trails, including the Gandy Dancer, Cattail, Tomorrow River, and Wiouwash trails and about 100,100 acres of state fisheries and wildlife management lands. The largest, Mead, McKenzie Creek, Little Wolf, and Upper Wolf State Wildlife Areas, each provide over 5,000 acres of recreational land.

■ **Trails.** The Forest Transition counties have over 9,000 miles of recreational trails (Table 11.4) and rank fifth (out of 16 ecological landscape county approximations) in trail density (Wisconsin DNR unpublished data). Compared to the state as a whole, there is a higher density of ATV and snowmobiling trails but a lower density of hiking, mountain and road biking, and cross-country ski trails.

■ **Campgrounds.** There are 253 public and privately owned campgrounds that provide about 12,544 campsites in the Forest Transition counties (Wisconsin DNR unpublished data). With 14% of the state's campgrounds, this ecological landscape county approximation ranks second (out of 16 ecological landscapes) in terms of number of campgrounds but 11th in campground density (campgrounds per square mile of land).

■ **Land Legacy Sites.** The Land Legacy project has identified over 300 places of significant ecological and recreational importance in Wisconsin, and 26 are either partially or totally located within the Forest Transition Ecological Landscape (WDNR 2006b). Three of them, the Chequamegon-Nicolet National Forest, the Menominee County Forest, and the Straight River Channel, are rated as having the highest conservation significance. The Chequamegon-Nicolet National Forest is also rated as having the highest recreational potential.

■ **State Natural Areas.** In addition, there are 9,318 acres of state natural areas either partially or totally located within the Forest Transition Ecological Landscape, of which 98% are publicly owned (including government and educational institutions), and 2% are owned by private interests (including NGOs) (Wisconsin DNR unpublished data). The largest state natural areas in the Forest Transition Ecological Landscape include Cathedral Pines (1,935 acres, Oconto County), the Mead Conifer Bogs (932 acres, Marathon, Portage, and Wood counties), South Branch Beech Grove (554 acres, Oconto County), Cedar Creek Wetlands (519 acres, Chippewa County), and Tunnel Channel Woods (458 acres, Polk County). Most of these occur within other public lands. For more information on Wisconsin state natural areas, see the Wisconsin DNR website (WDNR 2015e).

Demand

■ **Visitors to State Lands.** In 2006 there were an estimated 980,000 visitors to state recreation areas and parks in the Forest Transition Ecological Landscape (Wisconsin DNR unpublished data). The parks that attracted the most visitors were Interstate, Rib Mountain, and Council Grounds State Parks.

■ **Fishing and Hunting License Sales.** Of all license sales, the highest revenue producers for the Forest Transition counties were resident hunting licenses (47% of total sales), resident fishing licenses (26% of total sales), and nonresident fishing licenses (17% of total sales) (Wisconsin DNR unpublished data). Table 11.5 shows a breakdown of various licenses sold in the Forest Transition counties in 2007. Marathon County accounts for both the highest number of licenses sold and the highest revenue from sales. The Forest Transition counties account for about 14% of total license sales in the state. However, persons buying licenses in the Forest Transition counties may travel to other parts of the state to use them.

■ **Metropolitan Versus Nonmetropolitan Recreation Counties.** Johnson and Beale (2002) classified Wisconsin counties according to their dominant characteristics. One classification is "nonmetro recreation county." This type of county is characterized by high levels of tourism, recreation, entertainment, and seasonal housing. None of the Forest Transition counties are classified as a nonmetro recreation county.

Recreational Issues

Results of a statewide survey of Wisconsin residents indicated that a number of current issues are affecting outdoor recreation opportunities within Wisconsin (WDNR 2006a). Many of these issues, such as increasing ATV usage, overcrowding, increasing multiple-use recreation conflicts, loss of public access to lands and waters, invasive species, and poor water quality, are common across many regions of the state.

Table 11.4. *Miles of trails and trail density in the Forest Transition counties compared to the whole state.*

Trail type	Forest Transition (miles)	Forest Transition (miles/100 mi^2)	Wisconsin (miles/100 mi^2)
Hiking	329	2.6	2.8
Road biking	387	3.1	4.8
Mountain biking	217	1.7	1.9
ATV: summer & winter	2,916	23.1	9.3
Cross-country skiing	819	6.5	7.2
Snowmobile	4,374	34.7	31.2

Source: Wisconsin DNR unpublished data.

Table 11.5. *Fishing and hunting licenses and stamps sold in the Forest Transition counties.*

County[a]	Resident fishing	Nonresident fishing	Misc. fishing	Resident hunting	Nonresident hunting	Stamps	Total
Barron	17,618	15,976	354	22,318	839	5,646	62,751
Chippewa	18,565	3,955	498	25,099	391	4,608	53,116
Clark	4,355	271	112	11,119	192	1,680	17,729
Langlade	11,584	1,911	238	14,830	268	5,215	34,046
Lincoln	10,846	3,709	284	14,024	310	3,564	32,737
Marathon	28,187	2,920	870	49,020	983	11,739	93,719
Polk	11,836	11,780	390	18,949	1,580	5,061	49,596
Portage	16,109	1,355	433	24,271	397	7,328	49,893
Shawano	9,700	1,228	310	11,750	84	3,938	27,010
Taylor	5,338	572	173	11,055	207	1,758	19,103
Washburn	7,900	11,729	171	9,485	773	2,630	32,688
Waupaca	17,570	5,027	779	29,244	214	8,102	60,936
Wood	17,140	1,314	737	33,577	261	6,834	59,863
Total	**176,748**	**61,747**	**5,349**	**274,741**	**6,499**	**68,103**	**593,187**
Sales	**$4,071,430**	**$2,569,155**	**$111,936**	**$7,229,973**	**$969,032**	**$545,264**	**$15,496,790**

Source: Wisconsin DNR unpublished data, 2007.
[a]There are no data for Menominee County.

■ Silent Sports Versus Motorized Sports. Over the next decade, the most dominant recreation management issues will likely revolve around conflicts between motorized and nonmotorized recreation interests. From a silent-sport perspective, noise pollution from motorized users is one of the higher causes for recreation conflict (WDNR 2006a). Recreational motorized vehicles include snowmobiles, ATVs, motor boats, and jet skis. ATV use is especially contentious. ATV riding has been one of the fastest growing outdoor recreational activities in Wisconsin.

■ Timber Harvesting. A high percentage of statewide residents are concerned about timber harvesting in areas where they recreate (WDNR 2006a). Their greatest concern about timber harvesting is large-scale visual changes (i.e., large openings) in the forest landscape. Forest thinning and harvesting that creates small openings is more acceptable. Silent-sport enthusiasts as a group are the most concerned about the visual impacts of harvesting, while hunters and motorized users are somewhat less concerned.

■ Loss of Access to Lands and Waters. With the ever-increasing development along shoreline properties and continued parcelization of forestlands, there has been a loss of readily available access to lands and waters within this ecological landscape. This may be due to the concentration of housing that has occurred with the advent of housing developments closing large areas of shoreline once open to the casual recreational user. Another element that may play into the perception of reduced access is a lack of information about where to go for recreational opportunities. This element was highly ranked as a barrier to increased outdoor recreation in a statewide survey (WDNR 2006a).

Agriculture

Farm numbers in the Forest Transition counties decreased 33% between 1970 and 2002 (USDA NASS 2004). There were approximately 26,460 farms in 1970 and 17,859 in 2002. Between 1970 and 2002, average farm size increased from 187 acres to 204 acres, equal to the statewide average of 204 acres. The overall land in farms steadily decreased since the 1970s (Figure 11.14). In 1970 there were about 4.8 million acres of farmland, and by 2002 acreage was down to 3.7 million acres, a decrease of 24%. For the 14 counties, the percentage of land in farms ranges from 17% to 62%. The counties with the highest percentage of agricultural land are Barron, with 62%, and Clark, with 59%.

Agriculture is an important part of the economy of the Forest Transition counties. In 2002 net cash farm income totaled $330 million, or an average of $91 per agricultural acre, equal

Ginseng is a specialty export crop for which Wisconsin is a major supplier. Much of Wisconsin's supply is grown in this ecological landscape, including the Wausau area. Photo by Wisconsin DNR staff.

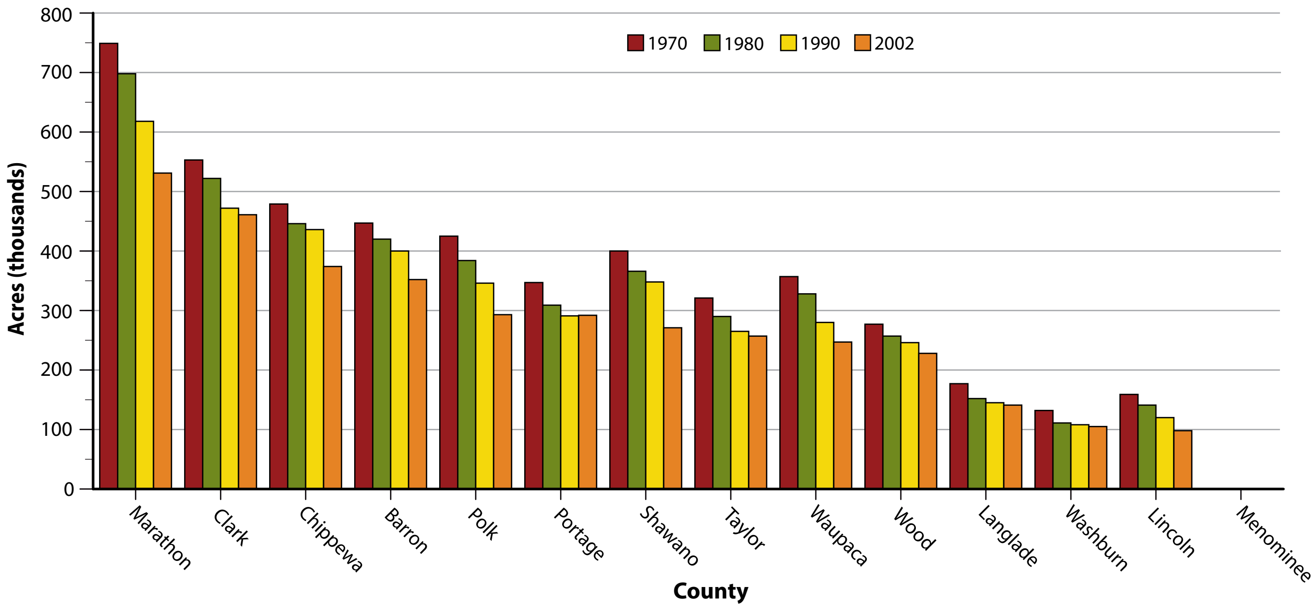


Figure 11.14. *Acres of farmland in the Forest Transition counties by county and year (USDA NASS 2004).*

to the statewide average (USDA NASS 2004). Also in 2002, the market value of all agriculture products sold in the Forest Transition counties was $1.3 billion (14% of state total); 26% of this amount came from crop sales, while the remaining 74% was from livestock sales. Marathon, Clark, and Barron counties all have a very high market value for the agricultural products they sell as well as their net farm income. Clark and Marathon counties are significant producers of milk.

In 2007, 30,140 acres of farmland had been sold, of which 89% stayed in agricultural use, at an average selling price of $2,568, and 11% was diverted to other uses, at an average sale price of $3,203 per acre (USDA NASS 2009).

Timber

Timber Supply

Based on 2007 Forest Inventory and Analysis (FIA) data (USFS 2009), 44% (2,010,322 acres) of the total land area of the Forest Transition Ecological Landscape is forested. This is 12.3% of Wisconsin's total forestland acreage.

Timberland Ownership. Timberland is defined as forestland capable of producing 20 cubic feet of industrial wood per acre per year and not withdrawn from timber utilization. Of all timberland within this ecological landscape, 87% is owned by private landowners, 9% is owned by state and local governments, and 4% is federally owned (Figure 11.15) (USFS 2009).

Growing Stock and Sawtimber Volume. There were approximately 2.9 billion cubic feet of growing stock volume in the Forest Transition Ecological Landscape in 2007, or 14% of total timber volume in the state (USFS 2009). Most of this volume (80%) was in hardwoods, greater than the proportion of hardwoods statewide (74% of Wisconsin's total growing stock volume). Hardwoods comprised a lower proportion of ***sawtimber*** volume (71%). In comparison, sawtimber hardwood volume was 67% of total volume statewide.

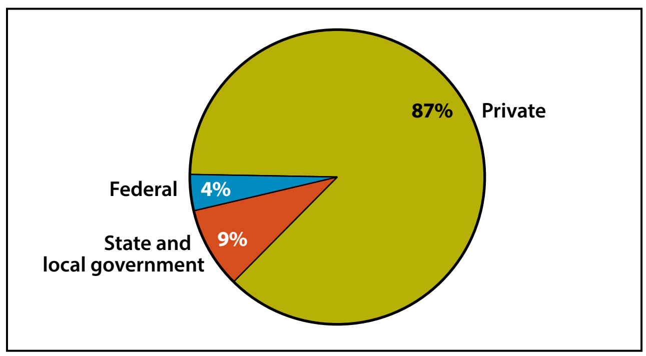


Figure 11.15. *Timberland ownership in the Forest Transition Ecological Landscape (USFS 2009).*

Stacks of cut timber piled in front of a mill on the Wisconsin River. Photo by Wisconsin DNR staff.

Annual Growing Stock and Sawtimber Growth. Between 1996 and 2007, the timber resource in the Forest Ecological Landscape increased by 193 million cubic feet, or 7% (USFS 2009). Most of this increase, 52%, occurred in softwood volume. Sawtimber volume increased by 1.1 billion board feet, or 16%. Most of this change (54%) was in hardwood volume. Estimated timberland acreage decreased slightly in the Forest Transition Ecological Landscape from 2,023,831 in 1996 to 1,981,304, or 2% between 1996 and 2007, although this estimated change is not statistically significant. Statewide, timberland acreage increased by 3% during the same time period (USFS 2009).

Timber Forest Types. According to Forest Inventory and Analysis data (USFS 2009), the predominant forest type groups (see Appendix H, "Forest Types That Were Combined into Forest Type Groups Based on Forest Inventory and Analysis (FIA) Data," in Part 3, "Supporting Materials") in terms of acreage are 25% maple-beech-birch, 24% aspen-birch, 20% oak-hickory, and lesser amounts of bottomland hardwoods, eastern white, red, and jack pine, and spruce-fir. Acreage is predominantly in the sawtimber and pole size classes (40 and 41%, respectively) with only 17% in seedling and sapling classes (Table 11.6).

Table 11.6. *Acreage of timberland in the Forest Transition Ecological Landscape by forest type and size class.*

Forest type[a]	Seedling/sapling	Pole-size	Sawtimber	Total
Aspen	105,974	177,143	50,783	333,900
Hard maple-basswood	5,717	77,722	131,892	215,331
Black ash-American elm-red maple	17,442	67,910	16,960	102,312
White oak-red oak-hickory	–	22,636	73,423	96,059
Red maple-upland	7,870	52,423	33,334	93,627
Northern red oak	1,607	9,012	78,914	89,532
Red pine	3,525	25,264	49,062	77,850
Post oak-blackjack oak	–	5,592	37,990	43,582
White birch	11,527	26,953	4,024	42,504
Cherry-ash-yellow-poplar	16,984	13,040	6,143	36,167
Northern white-cedar	4,528	22,326	8,241	35,095
Eastern white pine	7,052	5,850	20,628	33,530
White pine-red oak-white ash	10,998	10,274	12,124	33,397
Mixed upland hardwoods	13,642	8,568	10,579	32,788
Tamarack	17,000	11,402	2,938	31,340
Red maple-lowland	6,958	16,005	4,802	27,765
Sugarberry-hackberry-elm-green ash	3,042	19,949	4,431	27,422
Balsam fir	12,364	12,363	1,536	26,263
Eastern hemlock	–	906	23,318	24,224
Black spruce	9,047	12,545	–	21,592
Red maple-oak	700	11,531	6,997	19,227
Nonstocked[b]				19,042
White oak	–	–	18,355	18,355
Elm-ash-locust	4,565	2,666	2,683	9,914
Sycamore-pecan-American elm	-	6,612	2,873	9,485
White spruce	3,476	2,235	3,446	9,156
Other pine-hardwood	–	3,385	5,315	8,700
Silver maple-American elm	–	768	7,755	8,523
Exotic softwoods & hardwoods				8,359
White pine-hemlock	–	2,857	3,072	5,928
Jack pine	–	2,563	2,372	4,935
Bur oak	–	1,274	3,008	4,282
Black cherry	2,719	680	–	3,399
Total	**266,735**	**632,455**	**626,995**	**1,553,586**

Source: U.S. Forest Service Forest Inventory and Analysis (FIA) Mapmaker (USFS 2009).

[a] U.S. Forest Service Forest Inventory and Analysis (FIA) uses a national forest typing system to classify FIA forest types from plot and tree list samples. Because FIA is a national program, some of the national forest types in the above table do not exactly represent forest types that occur in Wisconsin. For example, neither post oak nor blackjack oak occur to any great extent in Wisconsin, but since there is no "black oak forest type" in the FIA system, black oak stands in Wisconsin were placed in the "post oak-blackjack oak" category in this table.

[b] Nonstocked land is less than 16.7% stocked with trees and not categorized as to forest type or size class.

Timber Demand

Removals from Growing Stock. The Forest Transition Ecological Landscape has about 14% of the total growing stock volume on timberland in Wisconsin (USFS 2009; see "Socioeconomic Characteristics" in Chapter 3, "Comparison of Ecological Landscapes"). Average annual removals from growing stock for this ecological landscape were 48 million cubic feet, or about 14% of total statewide removals (349 million cubic feet) between 2002 and 2007. Average annual removals to growth ratios vary by species as can be seen in Figure 11.16 (only the major species are shown). Growth exceeds removals for almost all major species.

Removals from Sawtimber. The Forest Transition Ecological Landscape has about 14% of the total sawtimber volume on timberland in Wisconsin (USFS 2009). Average annual removals from sawtimber for this ecological landscape were over 145 million board feet, or 13.8% of total statewide removals (1.1 billion board feet) between 2002 and 2007. Average annual removals to growth ratios vary by species as can be seen in Figure 11.17 (only major species shown).

Price Trends

In the Forest Transition counties, sugar maple and northern red oak were the highest priced hardwood sawtimber species in 2007. Northern white-cedar, red pine, and eastern white pine were the most valuable softwood timber. Sawtimber prices for 2007 were much higher for softwoods and similar to hardwood prices, compared to the rest of the state (WDNR 2008a). For pulpwood, red pine is the most valuable species. Pulpwood values in the Forest Transition counties were generally higher for both softwoods and hardwoods compared to the Wisconsin average.

Infrastructure

Transportation

The transportation infrastructure of the Forest Transition Ecological Landscape is somewhat less developed than the rest of the state. For instance, road mile density is 7% lower (WDOT 2000), railroad density is 19% lower (WDOT 1998), and airport runway density is 17% lower than the state as a whole. There are 14 airports in the Forest Transition Ecological Landscape, one of which is a primary regional airport (WDOT 2010). The Central Wisconsin Airport at Mosinee handles 3% of all passengers in the state. There are no shipping ports in this ecological landscape (Table 11.7).

Renewable Energy

Hydroelectric and wind turbine power are the only renewable energy sources quantified by county in Wisconsin energy statistics produced by the Wisconsin Department of Administration (WDOA 2006). The Forest Transition Ecological Landscape has the potential to produce a significant amount of renewable energy, especially woody biomass, corn-based ethanol, and hydroelectric. This ecological landscape currently has one ethanol plant but no wind generating facilities.

Biomass. Woody biomass is Wisconsin's most-used renewable energy resource, and the Forest Transition Ecological Landscape produces 152.5 million oven-dry tons of biomass, or 15.3% of total production (USFS 2009). Approximately 44% of the land base is forested, and acreage in forest decreased by 2% in the last decade.

Hydroelectric. There are eight hydroelectric power sites that generate 222.9 million kilowatt hours (kWh) (15.4% of the state's electricity produced by hydroelectric plants) (WDOA

Table 11.7. *Road miles and density, railroad miles and density, number of airports, airport runway miles and density, and number of ports in the Forest Transition Ecological Landscape.*

	Forest Transition	State total	% of state total
Total road length (miles)[a]	22,692	185,487	12%
Road density[b]	3.2	3.4	–
Miles of railroads	556	5,232	11%
Railroad density[c]	7.8	9.7	–
Airports	14	128	11%
Miles of runway	10.4	95.7	11%
Runway density[d]	1.5	1.8	–
Total land area (square miles)	7,099	54,087	13%
Number of ports[e]	0	14	0%

[a]Includes primary and secondary highways, roads, and urban streets.
[b]Miles of road per square mile of land. Data from Wisconsin Roads 2000 TIGER line files (data set) (WDOT 2000).
[c]Miles of railroad per 100 square miles of land. Data from 1:100,000-scale Rails Chain Database (WDOT 1998).
[d]Miles of airport runway per 1,000 square miles of land. Data from Wisconsin Airport Directory 2009–2010 web page (WDOT 2010).
[e]Data from Wisconsin Commercial Ports Association (WCPA 2010).

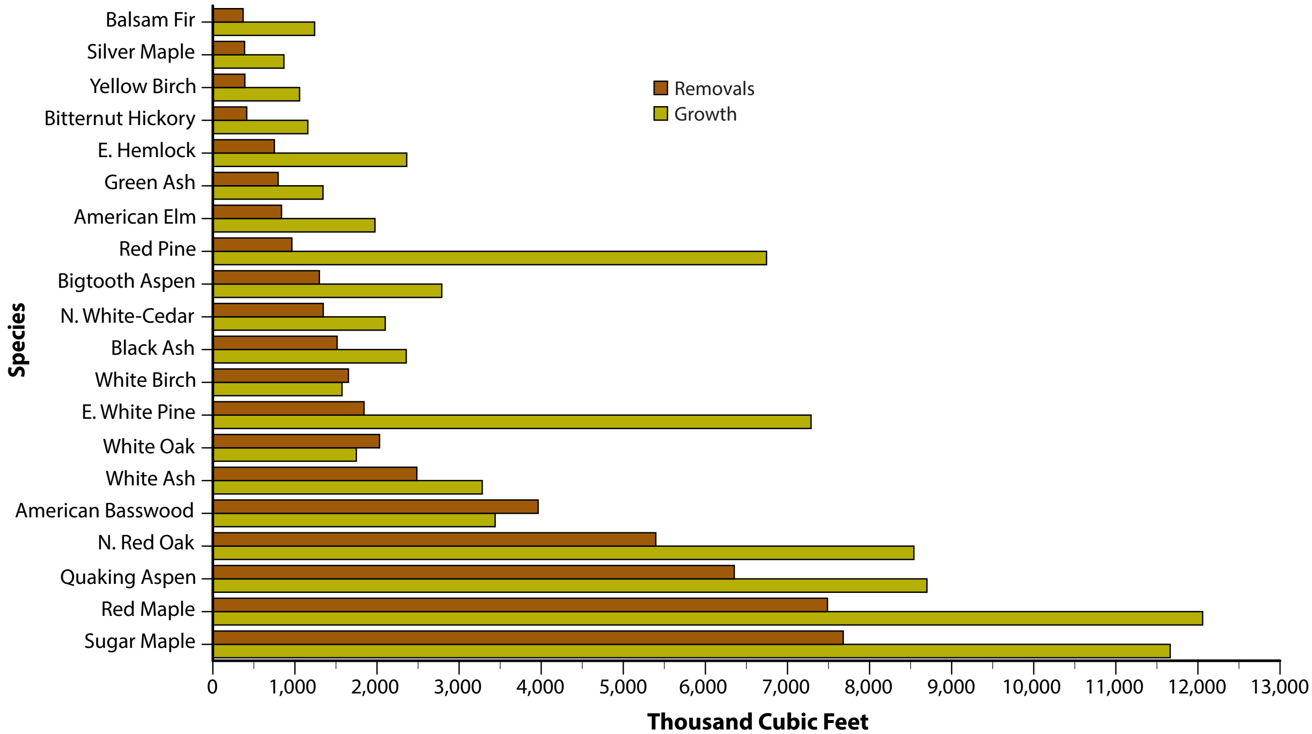


Figure 11.16. *Growing stock growth and removals (selected species) on timberland in the Forest Transition Ecological Landscape (USFS 2009).*

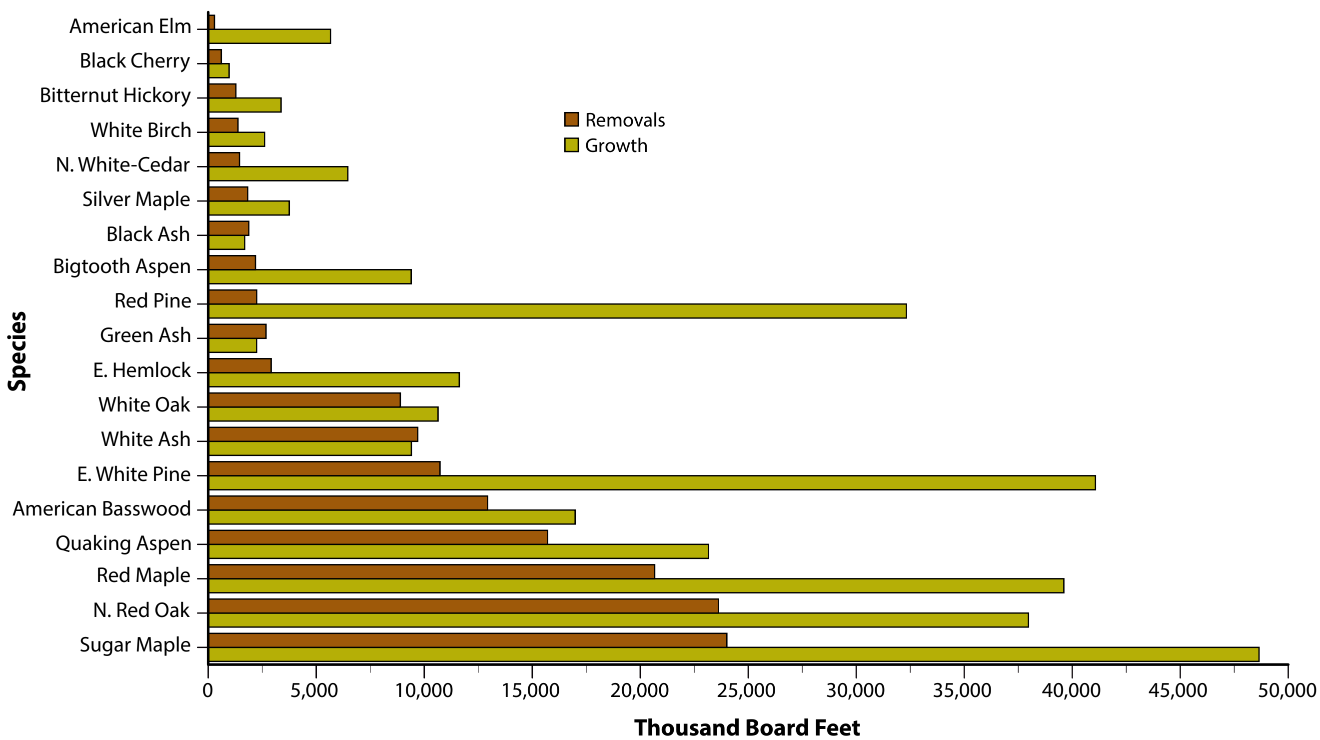


Figure 11.17. *Sawtimber growth and removals (selected species) on timberland in the Forest Transition Ecological Landscape (USFS 2009).*

2006). In the entire state, there are 68 sites, owned either by utility companies or privately owned, which generate a total of 1,462 million kilowatt hours. Some of the important hydroelectric plants in the Forest Transition Ecological Landscape are on the Wisconsin and Chippewa rivers.

■ **Ethanol.** The Forest Transition counties produced 66.5 million bushels of corn in 2002, or 11.2% of total production in the state (USDA NASS 2004). The acreage in agriculture makes use of 44% of the land base (some woodland is counted as agriculture by this source) but decreased by 24% between 1970 and 2002. There is one ethanol plant located at Stanley that produces 41 million gallons/year, or 8% of the state's total ethanol production (Renewable Fuels Association 2015).

■ **Wind.** There are no sited or proposed commercial wind facilities in the Forest Transition Ecological Landscape (WWIC 2014). Mean annual power densities in this part of the state are generally below 200 W/m^2 (watts/square meter), which may limit the potential for wind generation (USDE 2015).

Current Socioeconomic Conditions

The Forest Transition Ecological Landscape forms a band across central and northwest Wisconsin, sharing boundaries with 11 other ecological landscapes. Of the 14 Forest Transition counties, only five (Polk, Barron, Clark, Marathon, and Langlade) have greater than half of their area encompassed by the Forest Transition Ecological Landscape. Because of this transitional nature inherent in the name, Forest Transition counties have highly variable demographics.

The Forest Transition counties are traditionally rural but have increasing dependency on their urban centers for the bulk of local economic output. The largely homogenous white population of Forest Transition counties is growing in urban areas, while the population in rural counties is getting older, becoming smaller, and experiencing decreased economic activity. Both home values and property values are relatively low in most Forest Transition counties. Their citizens have lower levels of education attainment compared to much of the state, with negative implications for economic activity and health. While loss of a younger workforce and low wages are hindrances to many Forest Transition counties, expanding urban centers present economic opportunities in the region.

Demography

Population Distribution

According to the U.S. Census Bureau, the 2010 population of the 14 Forest Transition counties was 649,922, or 11.4% of the state total population (USCB 2012a). Over 58% of the population in the Forest Transition counties can be classified as rural populations, compared to 31.7% statewide. Of the 14 Forest Transition counties, only Wood, Portage, and Marathon counties have greater than half their population living in metropolitan areas (all or mostly near the Wisconsin River). The Forest Transition counties contain four metropolitan counties as classified by the U.S. Department of Agriculture Economic Research Service in 2004; Chippewa County with the city of Chippewa Falls and part of the Eau Claire metropolitan area, Wood County with the city of Marshfield, Portage County with the city of Stevens Point, and Marathon County, with the city of Wausau. Of 23 urban centers (defined as those cities with at least 2,500 inhabitants) in the Forest Transition counties, Wausau (39,302 according to recent U.S. Census Bureau estimates), Stevens Point (26,658) and Marshfield (18,691) are the largest cities. However, Stevens Point, Wisconsin Rapids, and seven other urban centers in the Forest Transition counties are actually located outside the boundaries of the ecological landscape itself. Though these cities and their accompanying demographics and local economies do have considerable influence on the ecological landscape as a whole, they tend to inflate figures representing the actual geographic area.

Population Density

Reflecting the region's rural character, the 2010 population density was lower than the statewide average in every Forest Transition county but covered a wide range. Wood (94 persons per square mile), Portage (87) and Marathon (87) counties had the highest population densities among the Forest Transition counties (USCB 2012a). Menominee (12), Washburn (20), and Taylor (21) counties had the lowest population densities among the Forest Transition counties. There are 51 persons per square mile in the Forest Transition counties combined, compared to 105 persons per square mile in Wisconsin as a whole.

Population Structure

■ **Age.** Forest Transition counties had a population age structure slightly skewed toward an older population compared to the entire state in 2010. The Forest Transition counties had slightly lower percentages of their population under 18 years of age (23.3% in Forest Transition counties compared to 23.6% statewide; USCB 2012a) and in the 25–49 age range (35.3% in Forest Transition counties compared to 36.9% statewide; USCB 2009). Forest Transition counties had a higher proportion of their population over 65 years of age (16.0%) compared to statewide (13.7%). Compared to the statewide median age of 36 years, only two Forest Transition counties were comparably lower: Menominee (28 years) and Portage (33 years). Washburn (42) and Langlade (40) have the highest median ages among the Forest Transition counties.

■ **Minorities.** The Forest Transition counties are less racially diverse than the state as a whole. Of the 2010 population in the Forest Transition counties, 94% was white, non-Hispanic, compared to 86% statewide (USCB 2012a). The most notable exception was Menominee County, which is made up almost exclusively of the Menominee Indian Reservation. Its American Indian population (88%) is the largest in the state.

Other demographic and socioeconomic figures in Menominee County are heavily influenced by poverty, isolation from urban centers, and lack of high-paying jobs. Shawano County contains the Stockbridge Munsee Reservation, which increases its American Indian population to 7.6%, compared to 1% statewide.

Education. With only a few exceptions, Forest Transition counties residents 25 years of age or older have lower education levels compared to the state as a whole. According to the 2010 U.S. census, 88% of Forest Transition counties residents 25 or older have graduated from high school, slightly lower than 89% statewide (USCB 2012a). Forest Transition counties residents also had less higher education attainment; 18.3% of Forest Transition counties residents have received at least a bachelor's degree or higher, compared to 25.8% statewide. Portage County, home of the University of Wisconsin-Stevens Point, is the lone Forest Transition county in which both high school degree attainment (90.4%) and bachelor's degree or higher attainment (27.1%) slightly exceeds statewide averages. Polk (91%) and Washburn counties (90%) are the only other Forest Transition counties exceeding statewide high school graduation rates. Clark County has the state's lowest rate of high school attainment (81%), followed closely by the third and fourth lowest rates statewide in Menominee County (82%) and Taylor County (85%), respectively.

Population Trends

Over the extended period from 1950 to 2006, the Forest Transition counties' combined population grew at a slower rate (43% population growth) than the state's population (62%) (USCB 2009). During only one decade since the 1950s has population growth in the Forest Transition counties exceeded statewide growth—during the boom of the 1970s when the Forest Transition counties' population grew at more than twice the rate (13.4%) as the statewide population (6.5%). In the extended period from 1950 to 2006, only Portage (95% population growth) and Polk (78%) counties exceeded statewide population growth. Meanwhile, Forest Transition counties with less urban influence experienced slower population change to varying degrees, to the point of actual population loss in Langlade County (-7.5% population change) from 1950 to 2006. Clark (3% population growth) and Taylor (5%) counties experienced virtually no population growth over the same extended period.

In the 1960s and 1970s, Forest Transition counties combined showed relatively slow population growth marked by population losses in the most rural counties as small farms and communities were abandoned for greater opportunities in larger urban centers (USCB 2009). From 1960 to 1970, for example, only Portage County (29% growth), with the Wausau metropolitan area, grew faster than statewide numbers (12%). All other Forest Transition counties grew slower than the statewide rate as their remote populations moved to urban centers such as Wausau, Eau Claire, or the Twin Cities in Minnesota. By the period from 1970 to 1980, small metropolitan areas in Forest Transition counties were growing rapidly as the rural population declined. From 1980 to 1990, populations leveled off in Forest Transition counties (3% growth, compared to 4% statewide). The period from 1990 to 2000 saw increased growth both in Forest Transition counties and statewide (8.7% and 9.6%, respectively). Since 2000 many Forest Transition counties (Langlade, Taylor, and Wood counties) again experienced population losses.

Housing

Housing Density. Consistent with their rural identity, Forest Transition counties tend to have low housing densities. The Forest Transition counties' combined housing density in 2010 (24.7 housing units per square mile) was just over half the state's housing density (48.5 units per square mile) (USCB 2012b). Similar to population density, housing density was highest in Wood (43 units per square mile), Portage (37.5), Marathon (37.4), and Waupaca (34.0) counties. The lowest housing densities in the Forest Transition counties were in Menominee County (6.3 units per square mile) and Taylor County (10.9).

Seasonal Homes. Distribution of seasonal and recreational homes is highly varied among the Forest Transition counties. Seasonal and recreational homes comprised 8.5% of all housing stock in the Forest Transition counties combined in 2010, but they are much more prevalent in counties along the northern edge of the Forest Transition counties (USCB 2012c). Washburn (35.1%) and Menominee (31.7%) counties have the greatest proportion of recreational homes among the Forest Transition counties, and many more counties exceed the statewide average (6.3%). Only five Forest Transition counties have percentages of seasonal housing lower than the statewide average: Wood (0.9%), Marathon (2.0%), Portage (2.2%), Chippewa (4.0%), and Clark (4.9%).

Housing Growth. The Forest Transition counties' housing growth from 1950 to 1960 (28.1%) lagged behind statewide averages (40.4%) but drew closer to statewide housing growth through the 1960s (23.6% in Forest Transition counties versus 27.2% statewide) and surpassed it in the 1970s (33.5% in Forest Transition counties versus 30.3% statewide) (USCB 2009). Since then, housing growth in the Forest Transition counties has approximated that of the state as a whole. From 2000 to 2007, housing in the Forest Transition counties grew by 10.2%, compared to 10.3% statewide. During this time period, five Forest Transition counties had greater housing growth than the statewide average: Polk (15.2%), Chippewa (14.0%), Washburn (13.2%), Marathon (12.7%), and Barron (11.5%). Housing development in the Forest Transition counties in part reflects the dynamics of change in rural areas from exclusively farming-dependent to more diversified residency. The counties with greatest housing development recently are those located close to metropolitan areas, with the influence of the Minneapolis-St. Paul metropolitan area radiating out to Polk, Washburn, Barron, and Chippewa counties. Wausau has a similar effect in Marathon County.

Housing Values. Median housing values in 2005–2009 in all Forest Transition counties, except Polk County, were lower than the statewide median ($166,100) (USCB 2012a). Polk County ($169,000), Washburn ($148,300), Chippewa ($143,600), Portage ($140,800), and Marathon ($135,800) counties had the highest home values among Forest Transition counties, due largely to their proximity to larger urban centers. The remaining Forest Transition counties had housing values ranging from moderately low in Waupaca ($133,900) and Barron ($129,700) counties to very low in Clark ($108,600), Langlade ($107,700), and Menominee counties ($74,300).

The Economy

The Forest Transition counties are especially dependent on government, manufacturing, health care and social services, retail trade, and tourism for the majority of jobs. Agriculture and the forest products industry are important, supporting more than twice the proportion of jobs in these sectors compared to the state as a whole. Rural Forest Transition counties especially are experiencing a net in-migration of retirement age adults and out-migration of young adults, with negative implications for the available workforce. Per capita income and average wages per job are low in the Forest Transition counties, indicating a lack of higher paying jobs, but Forest Transition counties with more urban influence fare favorably. Though unemployment rates are moderately high, poverty rates are lower than statewide figures in most of the Forest Transition counties.

Income

Per Capita Income. Total personal income for the 14 Forest Transition counties in 2006 was $19 billion (9.9% of the state total) (Table 11.8; USDC BEA 2006). Marathon County ($4.32 billion), Wood County ($2.52 billion), and Portage County ($2.08 billion) are the major contributors of income among the Forest Transition counties. Combined per capita income in the Forest Transition counties in 2006 ($29,814) was lower than the statewide average of $34,405. Only Wood County ($33,950) and Marathon County ($33,444) approached the statewide average per capita income. Per capita income in the remaining Forest Transition counties ranged from average in Waupaca County ($31,662) to very low in Clark County ($24,376). Menominee County is an outlier, with the lowest per capita income statewide ($19,472).

Household Income. In 2005, estimates of median household income levels in the Forest Transition counties compared somewhat more favorably with statewide median household income ($47,141) than the per capita income figures (USCB 2009). Median household incomes in three Forest Transition counties equaled or exceeded statewide levels: Marathon ($49,992), Polk ($48,022), and Portage ($47,140). Median household incomes in the remaining Forest Transition counties were lower than statewide, ranging from Waupaca County's $45,272 to Langlade County's $36,299, according to U.S. Census Bureau estimates. Again, Menominee County had the lowest figure statewide (mean household income of $30,839).

Earnings Per Job. Similar to per capita income, 2006 average earnings per job in the Forest Transition counties ($31,660) were lower than the statewide average ($36,142) (Table 11.8;

Table 11.8. *Economic indicators for the Forest Transition counties and Wisconsin.*

	Per capita income[a]	Average earnings per job[a]	Unemployment rate[b]	Poverty rate[c]
Wisconsin	**$34,405**	**$36,142**	**4.7%**	**10.2%**
Barron	$27,584	$27,438	5.5%	10.5%
Chippewa	$27,459	$29,417	5.2%	9.2%
Clark	$24,376	$26,759	5.4%	12%
Langlade	$27,575	$27,152	6.0%	11.8%
Lincoln	$28,252	$30,496	5.5%	8.2%
Marathon	$33,444	$34,293	4.3%	6.8%
Menominee	$19,472	$26,155	11.1%	26.3%
Polk	$27,362	$28,090	5.8%	7.4%
Portage	$30,702	$31,575	4.5%	11.3%
Shawano	$27,497	$26,414	5.1%	9.6%
Taylor	$25,465	$29,422	5.0%	9.9%
Washburn	$25,095	$25,881	6.6%	11.3%
Waupaca	$31,662	$29,833	5.0%	7.9%
Wood	$33,950	$38,242	5.3%	8.5%
Forest Transition counties	**$29,814**	**$31,660**	**5.1%**	**8.9%**

[a]U.S. Department of Commerce Bureau of Economic Analysis, 2006 figures.
[b]U.S. Department of Labor Bureau of Labor Statistics, Local Area Unemployment Statistics, 2006 figures.
[c]U.S.Census Bureau, Small Area Income and Poverty Estimates, 2005 figures.

USDC BEA 2006). Only Wood County ($38,242, ranked seventh among counties) had earnings per job higher than the statewide average. Earnings per job in the remaining Forest Transition counties ranged from quite low in Washburn County ($25,881) to moderate in Marathon County ($34,293).

Unemployment

The Forest Transition counties had a combined 2006 unemployment rate of 5.1%, slightly higher than the state average of 4.7% (Table 11.8; USDL BLS 2006). Marathon County (4.3% unemployment) and Portage County (4.5%) are the only Forest Transition counties that had relatively lower unemployment. These two counties also had the largest gross employment among the Forest Transition counties. Menominee County (11.1%) had the highest unemployment statewide. Washburn (6.6%) and Langlade (6.0%) also had some of the highest unemployment figures statewide. Unemployment rates were much higher throughout the state after 2008 but have become lower again.

Poverty

■ **Poverty Rates.** The U.S. Census Bureau estimates for the Forest Transition counties' combined 2005 poverty rate for all people (8.9%) was lower than for the state as a whole (10.2%) but highly variable among the Forest Transition counties (Table 11.8; USCB 2009). The 2005 poverty rate for all people in Menominee County (26.3%) was by far the highest among Wisconsin counties. Four other Forest Transition counties had moderately high poverty rates, ranging from 10.5% in Barron County to 11.8% in Langlade County. Conversely, 2005 poverty rates were especially low in Marathon (6.8%), Polk (7.4%), Waupaca (7.9%), and Lincoln (8.2%) counties.

■ **Child Poverty Rates**. Compared to the statewide average (14%), 2005 estimates of poverty rates for people under age 18 in the Forest Transition counties followed similar trends as overall poverty rates (USCB 2009). Child poverty rates were lowest in Waupaca (9.7%), Marathon (10.1%), Polk (10.1%), and Portage (10.6%) counties but very high in Menominee County (39.7%). Child poverty rates were moderately high in Washburn (17.4%), Clark (16.9%), Langlade (16.9%), and Barron (15.2%) counties. The remaining Forest Transition counties had moderately low child poverty rates ranging from 13.6% in Chippewa County to 10.9% in Wood County.

Residential Property Values

Average residential property value in the combined Forest Transition counties ($106,359 per housing unit) was lower than the statewide average ($134,021) in 2006 (Table 11.9). However, residential property values were highly variable among the Forest Transition counties and to a greater degree than housing values alone, since "residential property values" accounts for the value of recreational land value in addition to the home itself. Washburn County ($162,313) and Polk County ($155,668) were the only Forest Transition counties with residential property values higher than the state average. Washburn's high property values were attributable to the local prevalence of seasonal and recreational properties around lakes, while Polk County had the same phenomenon to a lesser degree and also is influenced by its proximity to the Twin Cities metropolitan area. Half of the Forest Transition counties were clustered with moderately low property values between $117,789 (Menominee County) and $101,571 (Portage County). The lowest property values were found in Clark ($64,683), Taylor ($75,341), and Wood ($84,625) counties. The Forest Transition counties with low residential

Table 11.9. *Property values for the Forest Transition counties and Wisconsin, assessed in 2006 and collected in 2007.*

	Residential property value	Housing units	Residential property value per housing unit
Wisconsin	**$340,217,559,700**	**2,538,538**	**$134,021**
Barron	$2,720,290,900	23,161	$117,451
Chippewa	$2,913,489,000	25,717	$113,290
Clark	$935,127,800	14,457	$64,683
Langlade	$1,114,305,400	12,012	$92,766
Lincoln	$1,651,000,400	15,769	$104,699
Marathon	$5,800,529,200	56,205	$103,203
Menominee	$260,902,900	2,215	$117,789
Polk	$3,744,121,400	24,052	$155,668
Portage	$2,934,090,500	28,887	$101,571
Shawano	$1,857,176,400	20,111	$92,346
Taylor	$690,350,400	9,163	$75,341
Washburn	$1,963,992,500	12,100	$162,313
Waupaca	$2,651,381,700	24,224	$109,453
Wood	$2,821,655,800	33,343	$84,625
Forest Transition counties	**$32,058,414,300**	**301,416**	**$106,359**

Sources: Wisconsin Department of Revenue 2006–2007 property tax master file (except housing units); housing units: U. S. Census Bureau estimates for July 1, 2006.

property values are rural and strongly agricultural with little recreational property.

Important Economic Sectors

Forest Transition counties together provided 377,564 jobs in 2007, or about 10.6% of the total employment in Wisconsin (Table 11.10; MIG 2009). Marathon County (90,603 jobs in 2007) had the greatest economic activity among the Forest Transition counties, followed by Wood County (52,662 jobs) and Portage County (43,240). Chippewa (31,818 jobs in 2007), Barron (28,808), and Waupaca (26,265) counties also contributed considerable economic activity. Menominee County (2,348 jobs in 2007) and Washburn County (6,708 jobs) contribute much less employment than their Forest Transition counties neighbors. The Government sector (12.5% of employment in the Forest Transition counties) was the leading source of employment in the Forest Transition counties in 2007, followed closely in terms of total jobs by Manufacturing (non-wood) (11.5%), Health Care and Social Services (11.1%), Retail Trade (10.0%), and Tourism-related (9.7%). Other important economic sectors in terms of jobs in the Forest Transition counties were Agriculture, Fishing, and Hunting (6.7% of the Forest Transition counties employment); Forest Products and Processing (5.9%); Other Services (5.6%); and Construction (5.4%) (MIG 2009). For definitions of economic sectors, see the U.S. Census Bureau's North American Industry Classification System web page (USCB 2013).

The importance of economic sectors within the Northeast Sands counties when compared to the rest of the state was evaluated using an economic base analysis to yield a standard metric called a location quotient (Quintero 2007). Economic base analysis compares the percentage of all jobs in an ecological landscape county approximation for a given economic sector to the percentage of all jobs in the state for the same economic sector. For example, if 10% of the jobs within an ecological landscape county approximation are in the manufacturing sector and 10% of all jobs in the state are in the manufacturing sector, then the quotient would be 1.0, indicating that this ecological landscape county approximation contributes jobs to the manufacturing sector at the same rate as the statewide average. If the quotient is greater than 1.0, the ecological landscape county approximation is contributing more jobs to the sector than the state average. If the quotient is less than 1.0, the ecological landscape county approximation is contributing fewer jobs to the sector than the state average.

When compared with the rest of the state, the Forest Transition counties had seven sectors of employment with quotients higher than 1.0 (Figure 11.18, Appendix 11.I). Only four of those sectors exceeded the statewide proportion of all jobs in the Forest Transition counties by more than 10%, an indicator of their particular prevalence locally. As evidence of how much the Forest Transition counties rely on their natural resource base, both the Agriculture, Fishing, and Hunting sector and the Forest Products and Processing sector provide

Table 11.10. *Total and percentage of jobs in 2007 in each economic sector within the Forest Transition (FT) counties. The economic sectors providing the highest percentage of jobs in the Forest Transition counties are highlighted in blue.*

Industry sector	WI employment	% of WI total	FT counties employment	% of FT counties total
Agriculture, Fishing & Hunting	110,408	3.1%	25,255	6.7%
Forest Products & Processing	88,089	2.5%	22,415	5.9%
Mining	3,780	0.1%	317	0.1%
Utilities	11,182	0.3%	468	0.1%
Construction	200,794	5.6%	20,467	5.4%
Manufacturing (non-wood)	417,139	11.7%	43,397	11.5%
Wholesale Trade	131,751	3.7%	13,292	3.5%
Retail Trade	320,954	9.0%	37,739	10.0%
Tourism-related	399,054	11.2%	36,581	9.7%
Transportation & Warehousing	108,919	3.1%	16,148	4.3%
Information	57,081	1.6%	4,502	1.2%
Finance & Insurance	168,412	4.7%	17,100	4.5%
Real Estate, Rental & Leasing	106,215	3.0%	6,820	1.8%
Professional, Science & Tech Services	166,353	4.7%	9,715	2.6%
Management	43,009	1.2%	2,451	0.6%
Administrative and Support Services	166,405	4.7%	8,075	2.1%
Private Education	57,373	1.6%	2,531	0.7%
Health Care & Social Services	379,538	10.7%	42,076	11.1%
Other Services	187,939	5.3%	20,997	5.6%
Government	430,767	12.1%	47,216	12.5%
Total	**3,555,161**		**377,564**	**10.6%**

Source: IMPLAN, © MIG, Inc. 2009 (MIG 2009).

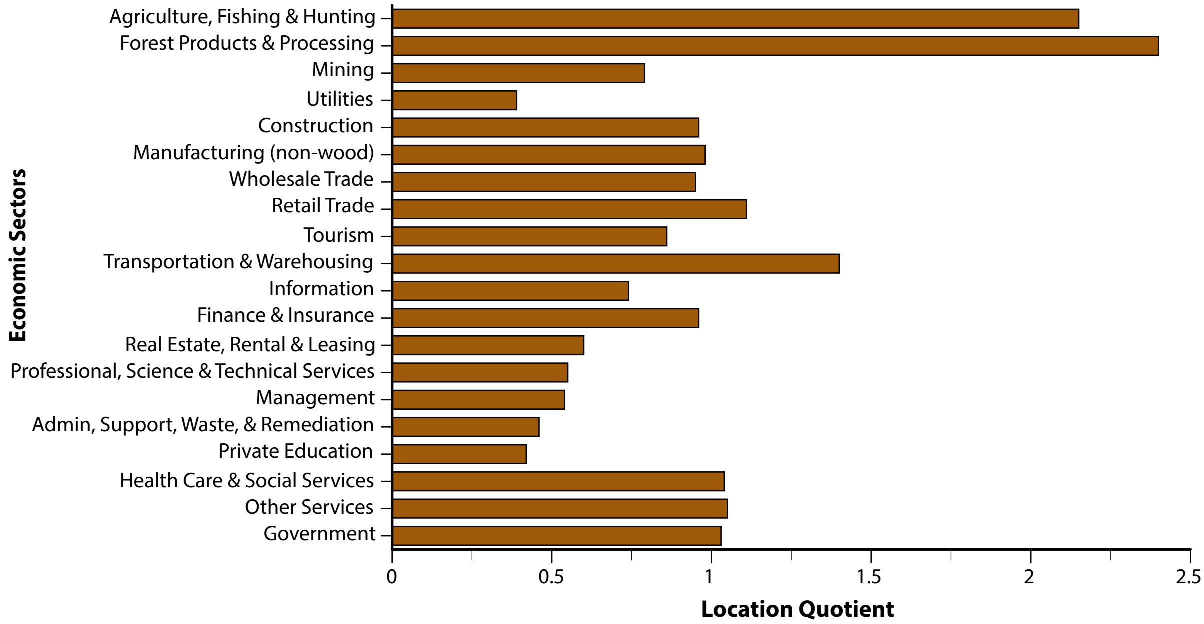


Figure 11.18. *Importance of economic sectors within the Forest Transition counties compared to the rest of the state. If the location quotient is greater than 1.0, the Forest Transition is contributing more jobs to that economic sector than the state average. If the location quotient is less than 1.0, the Forest Transition is contributing fewer jobs to that economic sector than the state average.*

jobs at more than twice the rate in Forest Transition counties compared to statewide. Forest Products and Processing has the highest location quotient in the Forest Transition counties among all sectors. The Forest Transition counties provide more than a quarter of all Forest Products and Processing sector jobs in the state, partially due to its proximity to paper mills. Similarly, Forest Transition counties contribute 22.4% of all Agriculture, Fishing, and Hunting sector jobs in the state. Other sectors providing a percentage of jobs in the Forest Transition counties higher than the state average, listed in order of their relative employment contribution are Transportation and Warehousing, Retail Trade, Other Services, Health Care and Social Services, and Government.

The Forest Products and Processing sector includes jobs in logging, pulp, and paper manufacturing, primary wood manufacturing (e.g., sawmills), and secondary wood manufacturing (e.g., furniture manufacturing). The Tourism-related sector includes relevant subsectors within Retail Trade, Passenger Transportation, and Arts, Entertainment, and Recreation. The Tourism-related sector also includes all accommodation and food services. The Tourism-related sector is not a separate economic sector as with other industrial classifications and is not easy to separate and identify. Businesses that service tourists also service local demands; however, they are the sectors most sensitive to tourism demands (Marcouiller and Xia 2008). The Other Services sector consists primarily of equipment and machinery repairing, promoting or administering religious activities, grant making, advocacy, and providing dry-cleaning and laundry services, personal care services, death care services, pet care services, photo finishing services, and temporary parking services.

Urban Influence

The U.S. Department of Agriculture's Economic Research Service (USDA ERS) divides counties into 12 groups on a continuum of urban influence, with 1 representing large metropolitan areas, 2 representing smaller metropolitan areas, and the remaining classes from 3 to 12 representing nonmetropolitan counties increasingly less populated and isolated from urban influence (USDA ERS 2012b). The concept of urban influence assumes population size, urbanization, and access to larger adjacent economies are crucial elements in evaluating potential of local economies. Chippewa County (bordering the Eau Claire metropolitan area) and Marathon County (containing the Wausau metropolitan area) are classified as smaller metropolitan areas (class 2). The remaining Forest Transition counties are composed of nonmetropolitan (rural) counties with varying degrees of "influence" from adjacent urban areas. Polk County is a class 4 county due to its proximity to the Twin Cities. Lincoln, Portage, and Wood counties are class 5 counties (adjacent to small metropolitan areas). Barron, Clark, Langlade, Shawano, Taylor, Washburn, and Waupaca counties are class 6 counties. Menominee County (class 7) receives the least urban influence of the Forest Transition counties.

Economic Types

Based on the assumption that knowledge and understanding of different types of rural economies and their distinctive economic and sociodemographic profiles can aid rural policymaking, the USDA ERS classifies counties in one of six mutually exclusive categories: farming-dependent counties, mining-dependent counties, manufacturing-dependent counties, government-dependent counties, service-dependent counties, and nonspecialized counties (USDA ERS 2012a). Eight Forest Transition counties (Barron, Chippewa, Lincoln, Marathon, Polk, Taylor, Waupaca, and Wood) were classified as manufacturing-dependent in 2004 according to the USDA Economic Research Service's economic specialization definitions. Clark County was the only Forest Transition county classified as Farming-dependent. Five Forest Transition counties (Langlade, Menominee, Portage, Shawano, and Washburn) were classified as nonspecialized.

Policy Types

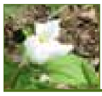
The USDA ERS also classifies counties according to "policy types" deemed especially relevant to rural development policy (USDA ERS 2012a). Of particular interest in the Forest Transition counties are the categories of "nonmetro recreation" counties and "retirement destination" counties. In 2004 Washburn County was classified as both a nonmetro recreation and retirement destination county. Nonmetro recreation counties are rural counties classified using a combination of factors, including share of employment or share of earnings in recreation-related industries in 1999, share of seasonal or occasional use housing units in 2000, and per capita receipts from motels and hotels in 1997, indicating economic dependence especially upon an influx of tourism and recreational dollars. Menominee County was categorized as a nonmetro recreation county. Waupaca and Polk counties were deemed retirement destination counties. Retirement destination counties are those in which the number of residents 60 and older grew by 15% or more between 1990 and 2000 due to in-migration; these counties are dependent on an influx of an aging population and have particular needs for health care and services specific to that population.

Menominee County carries two other classifications that indicate it is a locality with extraordinary economic stress. As a "housing stress" county, Menominee County is designated as one of 302 rural U.S. counties in which 30% or more of households had one or more of these housing conditions in 2000: lacked complete plumbing, lacked complete kitchen, paid 30% or more of household income for owner costs or rent, or had more than one person per room (USDA ERS 2012a). Menominee County was also categorized as one of 396 rural U.S. counties (and the only Wisconsin county) in which less than 65% of residents 21–64 years old were employed in 2000.

Integrated Opportunities for Management

Use of natural resources for human needs within the constraints of sustainable ecosystems is an integral part of ecosystem management. Integrating ecological management with socioeconomic programs or activities can result in efficiencies in land use, tax revenues, and private capital. This type of integration can also help generate broader and deeper support for sustainable ecosystem management. However, any human modification or use of natural communities has trade-offs that benefit some species and harm others. Even relatively benign activities such as ecotourism will have impacts on the ecology of an area. Trade-offs caused by management actions need to be carefully weighed when planning management to ensure that some species are not being irreparably harmed. Maintaining healthy, sustainable ecosystems provides many benefits to people and our economy. The development of ecologically sound management plans should save money and sustain natural resources in the long run.

The principles of integrating natural resources and socioeconomic activities are similar across the state. A discussion of "Integrated Ecological and Socioeconomic Opportunities" can be found in Chapter 6, "Wisconsin's Ecological Features and Opportunities for Management." That section offers suggestions on how and when ecological and socioeconomic needs might be integrated and gives examples of the types of activities that might work together when planning the management of natural resources within a given area.



Appendices

Appendix 11.A. *Watershed water quality summary for the Forest Transition Ecological Landscape.*

Watershed no.	Watershed name	Area (acres)	Overall water quality and major stressors[a] (Range = Very Poor/Poor/Fair/Good/Very Good/Excellent)
BR07	East Fork Black River	195,798	Fair to Good; cranberry marshes; temp; two lakes eutrophic from NPS
BR08	Five Mile & Wedges creeks	91,632	Fair to Good; streambank pasturing; beaver dams; hab; sed; temp; (only one lake)
BR09	O'Neill & Cunningham creeks	103,582	Fair to Good; streambank pasturing; erosion; hab; sed; flux; (no lake data)
BR10	Cawley & Rock creeks	108,028	Good; streambank pasturing > hab/sed; NPS
BR11	Popple River	138,724	Good; Streambank pasturing > hab/sed; beaver dams > flux/temp
BR12	Trappers & Pine creeks	85,955	Fair to Good; streambank pasturing > hab/sed; barnyard NPS > bacteria; erosion; chlorine toxicity
BR13	Black & Little Black rivers	102,919	Barnyard/urban NPS > hab/low D.O./bacteria/temp; chlorine toxicity; streambank pasturing > hab/sed
CW04	Hemlock Creek	61,690	Fair; water & wind soil erosion; sed; NPS; low D.O.; GW radon
CW05	Upper Yellow River	136,291	Poor to Fair; heavy water & wind erosion; high agr NPS; flux; impoundments eutrophic; hab
CW08	Wisconsin Rapids	85,707	Poor to V Good; hab; sed; urban NPS; wind erosion
CW09	Sevenmile & Tenmile creeks	71,834	Fair to Good; ditching; grazing, erosion; flux; temp; NPS/cranberry nitrates & pesticides hab; hi-cap wells
CW10	Fourmile & Fivemile creeks	136,933	Poor to Excellent; ditching; erosion; Sed; hab; NPS nutrients; low D.O.; pesticides; streambank grazing; hi-cap well > dry trout stream; impoundment weeds
CW11	Mill Creek	106,786	Poor to Good; streambank grazing; sed; hab; high runoff > bank erosion; impoundments; GW coliform
CW12	Plover & Little Plover rivers	129,402	Fair to Excellent; NPS pesticides/nutrients; hab; temp; sed; hi-cap well drawdown impacts on Little Plover > min flow order March 2009; lakes/ponds meso- to eutrophic
CW13	Little Eau Claire River	81,261	Fair; sed; hab; flux; high GW nitrate & pesticide
CW14	Little Eau Pleine River	168,510	Poor to V Good; GW herbicides, pesticides & fertilizers; erosion; low D.O.; urban NPS; waterfowl impoundments > poor fish habitat/sed; GW has high manganese
CW15	Johnson & Peplin creeks	40,360	Unknown (need baselxine monitoring); 45% forest; treated paper mill effluent; GW nitrate
CW16	Mosinee Flowage	52,372	Fair to V Good; 45% forest; erosion; streambank grazing > hab/sed
CW17	Lower Big Eau Pleine River	88,696	Poor to Excellent; high runoff > animal NPS > sed/algae; gravel mining > hab/flux; impoundments very eutrophic > low D.O. > fish kills
CW18	Upper Big Eau Pleine River	140,491	V Poor to Fair; 60% agr; agr & rural NPS/streambank grazing > flux > hab/low D.O.; dairy PS; GW Giardia
CW19	Bull Junior Creek	38,801	Unknown (need baseline monitoring); 45% forest; GW low pH/tetrachloroethylene
CW20	Lower Eau Claire River (Marathon County)	110,559	Fair to Excellent; 45% forest/32% agr; livestock grazing/gravel mines > NPS/hab; erosion; no lakes
CW21	Springbrook Creek	44,655	Good to V Good; 55% agr; livestock > hab/erosion/low D.O/nitrate; Antigo Lake eutrophic > sed/weeds; GW Good

Continued on next page

Appendix 11.A, *continued.*

Watershed no.	Watershed name	Area (acres)	Overall water quality and major stressors[a] (Range = Very Poor/Poor/Fair/Good/Very Good/Excellent)
CW22	Upper Eau Claire River	141,672	Poor to V Good; livestock grazing/gravel mine > erosion/ NPS/GW nitrate; many ERW streams; lakes P-sensitive
CW23	Lower Rib River	83,082	Poor to Good; 54% agr > erosion> NPS/sed/hab/flux/GW poor: nitrate/triazine; gravel mine; Lake Wausau eutrophic
CW24	Little Rib River	59,161	V Poor to Excellent; animal waste/manure pits > bacteria/NPS/ GW contamination; erosion > sed; hab; GW low pH
CW25	Black Creek	56,666	Poor to Good; animal waste NPS; streambank grazing > hab; gravel mining > sed
CW26	Upper Rib River	126,122	Fair to Excellent; 60% forest/40% agr; NPS; gravel mining; lakes need baseline monitoring
CW27	Trappe River	64,093	Fair to Good; 51% forest/23% agr; steep slopes > erosion; quarries > trib dewatering; beaver dams/gravel mines > temp; streambank grazing > hab
CW28	Devil Creek	43,838	Fair to Good; streambank grazing > hab/NPS/sed; manure spills
CW29	Pine Creek	82,471	V Good to Excellent; 51% forest; agr 14%; NPS/hab
GB05	Lower North Branch Oconto River	249,138	V Good to Excellent; beaver dams > sed/hab/temp/flux many high quality, mesotrophic lakes sensitive to P inputs.
GB06	South Branch Oconto River	140,332	V Good to Excellent; beaver dams > sed/temp/flux; lakes: Good to Excellent
GB10	Middle Peshtigo & Thunder rivers	123,867	Good to Excellent; beaver dams > sed/hab/temp/flux; impoundments> sed/Hg
GB12	Otter Creek & Rat River	90,565	V Good to Excellent; beaver dams > sed/hab/temp/flux
LC05	Hay River	185,343	Fair to Good; streambank grazing > sed/hab/temp; beaver dams; lake NPS > algae
LC06	South Fork Hay River	116,472	Poor to Fair; ditching/streambank pasturing/dams > sed/ hab/temp; lakes: NPS > algae/sed
LC07	Pine Creek & Red Cedar River	184,247	Fair to V Good; streambank pasturing/NPS/beaver dams > sed/hab/temp; Dallas Flowage eutrophic
LC08	Lake Chetek	135,683	Fair to V Good; woodlot/streambank pasturing > streambed erosion/hab/sed/temp; lakes: meso- to eutrophic; weedy
LC09	Yellow River	153,183	Fair to Excellent; streambank pasturing/urban & agr NPS > sed/hab/temp/bacteria/erosion; lakes meso- to eutrophic
LC10	Brill & Red Cedar rivers	190,518	Fair to V Good; beaver dams/streambank grazing > hab/sed/ temp; crop erosion > lakes meso- to eutrophic cropland erosion
LC15	Black & Hay creeks	102,328	Fair to Good; Dams > sed; temp; hab; eutrophic impoundments
LC16	South Fork Eau Claire River	146,871	Good; beaver dams/streambank grazing > hab/sed/temp; impoundments: eutrophic; Hg
LC17	North Fork Eau Claire River	131,767	Good to V Good; streambank grazing > hab; low D.O.; impoundment NPS > weeds/algae
LC18	Duncan Creek	122,522	Fair to Excellent; streambank grazing > low D.O./flux/sed; lakes: urban NPS > sed/algae/weedy
LC19	Lower Yellow River (Chippewa County)	177,181	Fair; agr NPS > hab/sed/excess nutrients; dams; lakes/ flowage: eutrophic
LC21	McCann Creek & Fisher River	199,078	Good to Excellent; streambank grazing > hab/sed/temp; NPS > excess nutrients; lakes: rural/urban NPS; eutrophic
SC02	Lower Willow River	105,204	Fair to Good; tribs Fair to Poor; loss of forest/infiltration; NPS agr
SC03	Upper Willow River	117,551	V Good; ERW; Loss of forest & vegetated buffer; flux
SC04	Lower Apple River	129,386	V Poor to Fair; loss of forest, buffers & wetlands; NPS agr nutrients
SC05	Balsam Branch	66,606	Fair to V Good; cropland/streambed erosion > nutrients/ temp/hab; lakes: meso- to eutrophic

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Appendix 11.A, *continued.*

Watershed no.	Watershed name	Area (acres)	Overall water quality and major stressors[a] (Range = Very Poor/Poor/Fair/Good/Very Good/Excellent)
SC06	Upper Apple River	125,074	Fair to Good; cropland/streambed erosion > nutrients/temp/hab; lakes: meso- to hypereutrophic
*c*SC07	Beaver Brook	41,483	Fair to Good; cropland/streambed erosion > sed/nutrients; lakes: some P-sensitive
SC08	Trout Brook	58,278	Poor to V Good; loss of forest, buffers & wetlands; lakes: some P-sensitive
SC09	Wolf Creek	70,515	Good to Excellent; beaver dams; sed/temp/hab/NPS; lakes: meso- to hypereutrophic
SC10	Trade River	124,754	Fair to V Good; streambank grazing > hab/sed; lakes eutrophic
SC11	Wood River	140,951	Fair to Excellent; beaver dams > sed/nutrients; lakes oligo- to eutrophic
SC12	Clam River	132,393	Good to Excellent; beaver dams > sed/nutrients/temp; lakes: meso- to hypereutrophic
SC13	North Fork Clam River	111,045	Good to Excellent; streambank pasturing/beaver dams > hab/temp; lakes: meso- to eutrophic
SC14	Lower Yellow River (Burnett County)	133,726	V Good to Excellent; beaver dams > hab/temp; lakes oligo- to eutrophic
SC15	Shell Lake & Upper Yellow River	106,666	V Good to Excellent; streambank pasturing/beaver dams > hab/temp; lakes: mesotrophic
SC21	Trego Lake – Middle Namekagon R	172,087	Good to V Good; streambank pasturing/beaver dams > hab/temp; lakes: meso- to eutrophic
UC01	Holcombe Flowage	109,043	Good to V Good; 70% forest; sand has covered cobble river substrate; some NPS; undeveloped softwater seepage & acid bog lakes
UC04	Upper South Fork Jump River	206,344	Fair to Excellent; agr NPS > low D.O. on one trib; some lightly developed softwater seepage & undeveloped acid bog lakes
UW30	Prairie River	168,954	V Good to Excellent; beaver dams/ditching > hab/sed/temp/flux; lakes Good to Excellent but many seepage and drainage lakes not studied
UW31	Copper River	65,949	Good to V Good; cranberry agr > pesticides; gravel mine; data needed for seepage and drainage lakes
UW32	New Wood River	74,070	Good to V Good; beaver dams > temp/hab; NPS > sed; few lakes
WR05	Waupaca River	186,096	Good to Excellent; agr NPS/erosion > trout hab/sed; dams; stream grazing > erosion; lakes mostly mesotrophic; GW pesticide/nitrate
WR06	Lower Little Wolf River	98,306	Fair to Good; agr crop erosion/animal waste > NPS; bank pasturing > hab; lakes: meso- to eutrophic; GW pesticide
WR07	Upper Little Wolf River	116,512	V Good; agr waste NPS/crop erosion > nutrients/sed/hab; NPS threatens water quality; data needed for seepage and spring lakes; GW pesticide
WR08	South Branch Little Wolf River	102,586	Fair to V Good; stream pasturing/agr NPS > erosion/sed/hab; lakes mesotrophic
WR09	North Branch & Mainstem Embarrass River	200,074	Poor to Excellent; severe agr waste NPS/erosion> nutrients/sed/weedy/low D.O.; lakes: meso- to eutrophic; EW milfoil
WR10	Pigeon River	74,444	Good; agr animal waste NPS/erosion > nutrients/sed/hab; dam; data needed for lakes
WR11	Middle & South Branches Embarrass River	160,003	Poor to Excellent; agr animal waste/erosion > NPS > nutrients/hab/weedy: low D.O.; lakes: meso- to eutrophic; less P-sensitive; GW pesticide
WR16	Red River	132,556	Good to V Good; agr/dairy; some lakes eutrophic; more data needed

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Appendix 11.A, *continued.*

Watershed no.	Watershed name	Area (acres)	Overall water quality and major stressors[a] (Range = Very Poor/Poor/Fair/Good/Very Good/Excellent)
WR17	West Branch Wolf River	170,311	Good to Excellent; large % forested; dams; agr; bait pond & fur farm runoff; beaver dams; lakes oligo- to mesotrophic; P-sensitive
WR18	Wolf River-Langlade & Evergreen rivers	115,035	Good to Excellent; 60%-100% forested tribs; beaver dams; heavy recreational use on Wolf River; seepage lakes meso- to eutrophic

Source: Wisconsin DNR Bureau of Watershed Management data.
[a]Based on Wisconsin DNR watershed water quality reports.

Abbreviations:
Agr = Agricultural.
D.O. = Dissolved oxygen.
ERW = Exceptional Resource Water (very good to excellent water quality, with point source discharges).
EW milfoil = Eurasian water-milfoil.
Flux = Abnormal highs and lows in stream flow fluctuation due to lack of groundwater infiltration, etc., often due to loss of forest cover, or creation of excessive impermeable surface.
GW = Groundwater (without modifiers, indicates high nitrates, radon, manganese or other negative use condition).
Hab = Stream habitat damage.
Hg = Mercury contamination of fish, mainly deposited by coal combustion, or sometimes by industry.
Hi-cap wells = High capacity wells.
NPS = Nonpoint source pollutants, such as farm or parking lot runoff, or septic system leakage.
P = Phosphorus in excessive amounts, reducing oxygen concentrations in a waterbody.
pH = Measurement of acidity/alkalinity.
PS = Point source pollutants, such as treated municipal and industrial wastewater.
Sed = Excess sedimentation.
Temp = Elevated temperatures in some stream reaches.
Tribs = Streams that are tributary to the stream(s) after which the watershed is named.
> = Yields, creates or results in.

Appendix 11.B. *Forest habitat types in the Forest Transition Ecological Landscape.*

The forest habitat type classification system (FHTCS) is a site classification system based on the floristic composition of plant communities. The system depends on the identification of potential climax associations, repeatable patterns in the composition of the understory vegetation, and differential understory species. It groups land units with similar capacity to produce vegetation. The floristic composition of the plant community is used as an integrated indicator of those environmental factors that affect species reproduction, growth, competition, and community development. This classification system enables the recognition and classification of ecologically similar landscape units (site types) and forest plant communities (vegetation associations).

A forest habitat type is an aggregation of sites (units of land) capable of producing similar late-successional (potential climax) forest plant communities. Each recognizable habitat type represents a relatively narrow segment of environmental variation that is characterized by a certain limited potential for vegetation development. Although at any given time, a habitat type can support a variety of disturbance-induced (seral) plant communities, the ultimate product of succession is presumed to be a similar climax community. Field identification of a habitat type provides a convenient label (habitat type name) for a given site, and places that site in the context of a larger group of sites that share similar ecological traits. Forest habitat type groups more broadly combine individual habitat types that have similar ecological potentials.

Individual forest cover types classify current overstory vegetation, but these associations usually encompass a wide range of environmental conditions. In contrast, individual habitat types group ecologically similar sites in terms of vegetation potentials. Management interpretations can be refined and made significantly more accurate by evaluating a stand in terms of the current cover type (current dominant vegetation) plus the habitat type (potential vegetation).

Habitat types	**Description of forest habitat types found in the Forest Transition Ecological Landscape.**
ATM	*Acer saccharum-Tsuga canadensis/Maianthemum canadense* Sugar maple-Eastern hemlock/Wild lily-of-the-valley
ATDH	*Acer saccharum-Tsuga canadensis/Dryopteris spinulosa-Hydrophyllum virginianum* Sugar maple-Eastern hemlock/Spinulose shield fern-Virginia waterleaf
TMC	*Tsuga canadensis/Maianthemum canadense-Coptis groenlandica* Eastern hemlock/Wild lily-of-the-valley-Goldthread
ATAtOn	*Acer saccharum-Tsuga canadensis/Athyrium filix-femina-Onoclea sensibilis* Sugar maple-Eastern hemlock/Lady fern-Sensitive fern
AH	*Acer saccharum/Hydrophyllum virginianum* Sugar maple/Virginia waterleaf
AAt	*Acer saccharum/Athyrium filix-femina* Sugar maple/Lady fern
ACaCi	*Acer saccharum/Caulophyllum thalictroides-Circaea quadrisulcata* Sugar maple/Blue cohosh-Enchanter's nightshade
AHVb	*Acer saccharum/Hydrophyllum virginianum-Viburnum acerifolium* Sugar maple/Virginia waterleaf-Maple-leaved viburnum
AHI	*Acer saccharum/Hydrophyllum virginianum-Impatiens capensis* Sugar maple/Virginia waterleaf-jewelweed
ASaI	*Acer saccharum/Sanguinaria canadensis-Impatiens capensis* Sugar maple/Bloodroot-Jewelweed
AVb-V	*Acer saccharum/Viburnum acerifolium (Vaccinium angustifolium* variant*)* Sugar maple/Maple-leaved viburnum (blueberry variant)
AVb	*Acer saccharum/Viburnum acerifolium* Sugar maple/Maple-leaved viburnum
AVDe	*Acer saccharum/Vaccinium angustifolium-Desmodium glutinosum* Sugar maple/Blueberry–Pointed-leaved tick trefoil

Source: Kotar et al. (2002).

Appendix 11.C. *The Natural Heritage Inventory (NHI) table of rare species and natural community occurrences (plus a few miscellaneous features tracked by the NHI program) for the Forest Transition (FT) Ecological Landscape in November 2009. See the Wisconsin Natural Heritage Working List online for the current status (http://dnr.wi.gov, keyword "NHI").*

Scientific name (common name)	Lastobs Date	EOs[a] in FT	EOs in WI	Percent in FT	State rank	Global rank	State status	Federal status
MAMMALS[b]								
Canis lupus (gray wolf)	2008	18	204	9%	S2	G4	SC/FL	LE
Reithrodontomys megalotis (western harvest mouse)	1976	1	11	9%	S3	G5	SC/N	
Sorex arcticus (arctic shrew)	2000	5	31	16%	S3S4	G5	SC/N	
Sorex hoyi (pygmy shrew)	1994	6	39	15%	S3S4	G5	SC/N	
Sorex palustris (water shrew)	1976	2	13	15%	S2S3	G5	SC/N	
Spermophilus franklinii (Franklin's ground squirrel)	1970	1	12	8%	S2	G5	SC/N	
BIRDS[c]								
Accipiter gentilis (Northern Goshawk)	2002	8	141	6%	S2B,S2N	G5	SC/M	
Ammodramus henslowii (Henslow's Sparrow)	2003	2	82	2%	S3B	G4	THR	
Ammodramus leconteii (Le Conte's Sparrow)	1988	1	22	5%	S2S3B	G4	SC/M	
Botaurus lentiginosus (American Bittern)	2005	2	41	5%	S3B	G4	SC/M	
Buteo lineatus (Red-shouldered Hawk)	2006	18	301	6%	S3S4B,S1N	G5	THR	
Coccyzus americanus (Yellow-billed Cuckoo)	2006	2	39	5%	S3B	G5	SC/M	
Coturnicops noveboracensis (Yellow Rail)	2005	1	22	5%	S1B	G4	THR	
Cygnus buccinator (Trumpeter Swan)	2001	3	22	14%	S4B	G4	SC/M	
Dendroica caerulescens (Black-throated Blue Warbler)[d]	2001	1	27	4%	S3B	G5	SC/M	
Dendroica cerulea (Cerulean Warbler)[d]	2006	3	92	3%	S2S3B	G4	THR	
Falco peregrinus (Peregrine Falcon)	2006	1	23	4%	S1S2B	G4	END	
Haliaeetus leucocephalus (Bald Eagle)	2008	148	1286	12%	S4B,S2N	G5	SC/P	
Lanius ludovicianus (Loggerhead Shrike)	1978	1	31	3%	S1B	G4	END	
Nycticorax nycticorax (Black-crowned Night-heron)	1983	2	36	6%	S2B	G5	SC/M	
Pandion haliaetus (Osprey)	2008	57	733	8%	S4B	G5	SC/M	
Phalaropus tricolor (Wilson's Phalarope)	2005	1	4	25%	S1B	G5	SC/M	
Podiceps grisegena (Red-necked Grebe)	1988	1	13	8%	S1B	G5	END	
Tympanuchus cupido (Greater Prairie-chicken)	2005	17	60	28%	S1B,S2N	G4	THR	
Tyto alba (Barn Owl)	1995	3	29	10%	S1B,S1N	G5	END	
Wilsonia canadensis (Canada Warbler)[d]	2001	1	20	5%	S3B	G5	SC/M	
HERPTILES								
Acris crepitans (northern cricket frog)	1981	2	102	2%	S1	G5	END	
Diadophis punctatus edwardsii (northern ring-necked snake)	1998	3	23	13%	S3?	G5T5	SC/H	
Emydoidea blandingii (Blanding's turtle)	2008	42	316	13%	S3	G4	THR	
Glyptemys insculpta (wood turtle)	2008	41	262	16%	S2	G4	THR	
Hemidactylium scutatum (four-toed salamander)	2008	4	63	6%	S3	G5	SC/H	
Lithobates catesbeianus (American bullfrog)	1995	8	70	11%	S3	G5	SC/H	
FISHES								
Acipenser fulvescens (lake sturgeon)	1991	3	99	3%	S3	G3G4	SC/H	
Ammocrypta clara (western sand darter)	1992	1	11	9%	S3	G3	SC/N	
Anguilla rostrata (American eel)	1983	1	24	4%	S2	G4	SC/N	
Aphredoderus sayanus (pirate perch)	1970	1	39	3%	S3	G5	SC/N	
Clinostomus elongatus (redside dace)	1995	26	96	27%	S3	G3G4	SC/N	
Crystallaria asprella (crystal darter)	2007	1	11	9%	S1	G3	END	
Cycleptus elongatus (blue sucker)	1989	1	8	13%	S2	G3G4	THR	
Erimyzon sucetta (lake chubsucker)	1979	1	85	1%	S3	G5	SC/N	
Etheostoma microperca (least darter)	1993	9	83	11%	S3	G5	SC/N	

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Appendix 11.C, *continued.*

Scientific name (common name)	Lastobs Date	EOs[a] in FT	EOs in WI	Percent in FT	State rank	Global rank	State status	Federal status
Fundulus diaphanus (banded killifish)	2000	20	105	19%	S3	G5	SC/N	
Ictiobus niger (black buffalo)	2000	1	11	9%	S2	G5	THR	
Lythrurus umbratilis (redfin shiner)	1976	1	37	3%	S2	G5	THR	
Moxostoma carinatum (river redhorse)	1978	3	43	7%	S2	G4	THR	
Moxostoma duquesnei (black redhorse)	1992	3	6	50%	S1	G5	END	
Moxostoma valenciennesi (greater redhorse)	1994	4	56	7%	S3	G4	THR	
Notropis anogenus (pugnose shiner)	1979	5	49	10%	S2	G3	THR	
Notropis nubilus (ozark minnow)	1976	7	24	29%	S2	G5	THR	
Notropis texanus (weed shiner)	1978	12	45	27%	S3	G5	SC/N	
Percina evides (gilt darter)	1978	1	26	4%	S2	G4	THR	
MUSSELS/CLAMS								
Alasmidonta marginata (elktoe)	2008	9	44	20%	S4	G4	SC/P	
Alasmidonta viridis (slippershell mussel)	1988	1	16	6%	S2	G4G5	THR	
Cumberlandia monodonta (spectacle case)[e]	2003	1	5	20%	S1	G3	END	C
Cyclonaias tuberculata (purple wartyback)	1998	3	16	19%	S1S2	G5	END	
Ellipsaria lineolata (butterfly)	2003	1	5	20%	S2	G4	END	
Elliptio crassidens (elephant ear)	1995	1	2	50%	S1	G5	END	
Epioblasma triquetra (snuffbox)[e]	2003	1	5	20%	S1	G3	END	
Lampsilis higginsii (Higgins' eye)	2004	1	7	14%	S1	G1	END	LE
Pleurobema sintoxia (round pigtoe)	1997	9	50	18%	S3	G4G5	SC/P	
Quadrula fragosa (winged mapleleaf)	2008	1	1	100%	S1	G1	END	LE
Quadrula metanevra (monkeyface)	1997	1	11	9%	S2	G4	THR	
Quadrula nodulata (wartyback)	2003	1	5	20%	S1S2	G4	THR	
Simpsonaias ambigua (salamander mussel)	1989	1	51	2%	S2S3	G3	THR	
Tritogonia verrucosa (buckhorn)	2003	1	12	8%	S2	G4G5	THR	
Venustaconcha ellipsiformis (ellipse)	1994	2	28	7%	S2	G4	THR	
BUTTERFLIES/MOTHS								
Boloria eunomia (bog fritillary)	2003	1	49	2%	S3	G5	SC/N	
Boloria freija (freija fritillary)	1978	1	20	5%	S2S3	G5	SC/N	
Callophrys henrici (Henry's elfin)	2006	1	19	5%	S1S2	G5	SC/N	
Chlosyne gorgone (gorgone checker spot)	2000	1	40	3%	S3	G5	SC/N	
Erebia discoidalis (red-disked alpine)	1978	1	8	13%	S2	G5	SC/N	
Erynnis persius (Persius dusky wing)	1998	1	26	4%	S2	G5	SC/N	
Hemileuca sp. 3 (midwestern fen buckmoth)	1974	1	10	10%	S3	G5T3T4	SC/N	
Hesperia leonardus (Leonard's skipper)	2000	2	29	7%	S3	G4	SC/N	
Lycaeides idas (northern blue)	1990	5	9	56%	S1	G5	END	
Lycaeides melissa samuelis (Karner blue)	1994	7	316	2%	S3	G5T2	SC/FL	LE
Lycaena dione (gray copper)	1991	1	14	7%	S2	G5	SC/N	
Phyciodes batesii lakota (Lakota crescent)	1984	1	24	4%	S3	G4T4	SC/N	
Pieris virginiensis (West Virginia white)	2002	1	25	4%	S3	G3G4	SC/N	
Poanes massasoit (mulberry wing)	2000	3	56	5%	S3	G4	SC/N	
Satyrodes eurydice fumosa (smokey eyed brown)	1988	1	8	13%	S2	G5T3T4	SC/N	
Schinia bina (bina flower moth)	1996	1	1	100%	S2?	G4	SC/N	
DRAGONFLIES/DAMSELFLIES								
Aeshna eremita (lake darner)	1985	1	15	7%	S3	G5	SC/N	
Nasiaeschna pentacantha (cyrano darner)	1992	1	14	7%	S3	G5	SC/N	
Neurocordulia molesta (smoky shadowfly)	1998	1	9	11%	S2S3	G4	SC/N	
Ophiogomphus howei (pygmy snaketail)	1999	7	33	21%	S4	G3	THR	
Ophiogomphus smithi (sand snaketail)	1997	4	28	14%	S2	G2G3	SC/N	

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Appendix 11.C, *continued.*

Scientific name (common name)	Lastobs Date	EOs[a] in FT	EOs in WI	Percent in FT	State rank	Global rank	State status	Federal status
Ophiogomphus susbehcha (Saint Croix snaketail)	2000	1	3	33%	S2	G1G2	END	
BEETLES								
Cicindela patruela huberi (a tiger beetle)	2000	3	84	4%	S3	G3T3	SC/N	
Haliplus pantherinus (a crawling water beetle)	2000	4	13	31%	S2S3	GNR	SC/N	
Laccobius agilis (a water scavenger beetle)	2000	1	4	25%	S2S3	GNR	SC/N	
MISCELLANEOUS INSECTS/SPIDERS								
Arphia conspersa (speckled rangeland grasshopper)	1998	1	8	13%	S2	G5	SC/N	
Attaneuria ruralis (a common stonefly)	1987	1	1	100%	S1?	G4	SC/N	
Booneacris glacialis (wingless mountain grasshopper)	2004	1	8	13%	S3	G5	SC/N	
Trimerotropis maritima (seaside grasshopper)	1998	1	3	33%	S2S3	G5	SC/N	
PLANTS								
Adlumia fungosa (climbing fumitory)	1977	1	29	3%	S2	G4	SC	
Amerorchis rotundifolia (round-leaved orchis)	1998	2	9	22%	S2	G5	THR	
Arabis missouriensis var. *deamii* (Deam's rockcress)	2003	3	22	14%	S2	G5?QT3?Q	SC	
Arethusa bulbosa (swamp-pink)	2004	3	96	3%	S3	G4	SC	
Artemisia dracunculus (dragon wormwood)	1993	1	5	20%	S2	G5	SC	
Asclepias ovalifolia (dwarf milkweed)	1993	1	60	2%	S3	G5?	THR	
Botrychium minganense (Mingan's moonwort)	1979	2	17	12%	S2	G4	SC	
Botrychium mormo (little goblin moonwort)	2000	1	82	1%	S3	G3	END	
Botrychium oneidense (blunt-lobe grape-fern)	1978	1	35	3%	S2	G4Q	SC	
Calamagrostis stricta (slim-stem small-reedgrass)	1982	1	34	3%	S3	G5	SC	
Callitriche hermaphroditica (autumnal water-starwort)	1995	1	11	9%	S2	G5	SC	
Cardamine pratensis (cuckooflower)	1983	2	42	5%	S3	G5	SC	
Carex assiniboinensis (Assiniboine sedge)	2001	6	33	18%	S3	G4G5	SC	
Carex crawei (Crawe sedge)	1998	2	24	8%	S3	G5	SC	
Carex gynocrates (northern bog sedge)	2004	4	31	13%	S3	G5	SC	
Carex prasina (drooping sedge)	2003	1	31	3%	S3	G4	THR	
Carex tenuiflora (sparse-flowered sedge)	1998	5	84	6%	S3	G5	SC	
Carex vaginata (sheathed sedge)	1982	1	35	3%	S3	G5	SC	
Ceratophyllum echinatum (prickly hornwort)	2004	3	61	5%	S2	G4?	SC	
Clematis occidentalis (purple clematis)	2006	3	32	9%	S3	G5	SC	
Corallorhiza odontorhiza (autumn coral-root)	2000	1	36	3%	S3	G5	SC	
Cypripedium arietinum (ram's-head lady's-slipper)	2001	1	21	5%	S2	G3	THR	
Cypripedium parviflorum var. *makasin* (northern yellow lady's-slipper)	2004	4	78	5%	S3	G5T4Q	SC	
Cypripedium reginae (showy lady's-slipper)	2004	13	99	13%	S3	G4	SC	
Diplazium pycnocarpon (glade fern)	2001	1	12	8%	S2	G5	SC	
Dryopteris expansa (spreading woodfern)	1981	1	13	8%	S2	G5	SC	
Dryopteris fragrans var. *remotiuscula* (fragrant fern)	1984	1	27	4%	S3	G5T3T5	SC	
Eleocharis olivacea (capitate spikerush)	1977	1	12	8%	S2	G5	SC	
Eleocharis quinqueflora (few-flower spikerush)	1983	2	18	11%	S2	G5	SC	
Eleocharis robbinsii (Robbins' spikerush)	2004	2	28	7%	S3	G4G5	SC	
Eriophorum alpinum (alpine cotton-grass)	1984	1	25	4%	S2	G5	SC	
Malaxis monophyllos var. *brachypoda* (white adder's-mouth)	2004	8	48	17%	S3	G4Q	SC	
Medeola virginiana (Indian cucumber-root)	2007	12	42	29%	S3	G5	SC	
Myriophyllum farwellii (Farwell's water-milfoil)	2009	3	60	5%	S3	G5	SC	
Opuntia fragilis (brittle prickly-pear)	1993	4	36	11%	S3	G4G5	THR	
Platanthera dilatata (leafy white orchis)	1983	5	31	16%	S3	G5	SC	

Continued on next page

Appendix 11.C, *continued.*

Scientific name (common name)	Lastobs Date	EOs[a] in FT	EOs in WI	Percent in FT	State rank	Global rank	State status	Federal status
Platanthera flava var. *herbiola* (pale green orchid)	2003	1	20	5%	S2	G4T4Q	THR	
Poa paludigena (bog bluegrass)	1993	1	41	2%	S3	G3	THR	
Potamogeton diversifolius (water-thread pondweed)	1994	1	29	3%	S2	G5	SC	
Potamogeton pulcher (spotted pondweed)	1986	1	1	100%	S1	G5	END	
Potamogeton vaseyi (Vasey's pondweed)	1994	5	19	26%	S2	G4	SC	
Ribes hudsonianum (northern black currant)	2006	3	76	4%	S3	G5	SC	
Scirpus heterochaetus (slender bulrush)	1980	1	2	50%	S1	G5	SC	
Scirpus torreyi (Torrey's bulrush)	2004	3	21	14%	S2	G5?	SC	
Silene nivea (snowy campion)	1976	1	6	17%	S2	G4?	THR	
Talinum rugospermum (prairie fame-flower)	1993	4	54	7%	S3	G3G4	SC	
Triglochin maritima (common bog arrow-grass)	1982	1	59	2%	S3	G5	SC	
Triglochin palustris (slender bog arrow-grass)	1982	1	36	3%	S3	G5	SC	
Utricularia geminiscapa (hidden-fruited bladderwort)	2004	2	95	2%	S3	G4G5	SC	
Utricularia purpurea (purple bladderwort)	2004	2	55	4%	S3	G5	SC	
Utricularia resupinata (northeastern bladderwort)	1988	1	29	3%	S3	G4	SC	
Vaccinium cespitosum (dwarf huckleberry)	2003	2	6	33%	S2	G5	END	
Valeriana sitchensis ssp. *uliginosa* (marsh valerian)	2000	2	16	13%	S2	G4Q	THR	
Viburnum nudum var. *cassinoides* (northern wild-raisin)	1973	1	6	17%	S2	G5T5	SC	
Viola rostrata (long-spur violet)	1979	1	22	5%	S2S3	G5	SC	
COMMUNITIES								
Alder Thicket	2007	17	106	16%	S4	G4	NA	
Bedrock Glade	2006	6	20	30%	S3	G2	NA	
Black Spruce Swamp	2007	3	41	7%	S3?	G5	NA	
Boreal Rich Fen	1988	1	18	6%	S2	G4G5	NA	
Calcareous Fen	2001	3	84	4%	S3	G3	NA	
Dry Cliff	1985	3	88	3%	S4	G4G5	NA	
Dry-mesic Prairie	1984	1	37	3%	S2	G3	NA	
Emergent Marsh	1999	16	272	6%	S4	G4	NA	
Ephemeral Pond	2006	1	11	9%	SU	GNRQ	NA	
Floodplain Forest	1998	11	182	6%	S3	G3?	NA	
Glaciere Talus	1998	1	6	17%	S2	G2G3	NA	
Hardwood Swamp	2006	3	53	6%	S3	G4	NA	
Inland Beach	2000	1	17	6%	S3	G4G5	NA	
Lake—Deep, Hard, Drainage	2006	12	30	40%	S3	GNR	NA	
Lake—Deep, Hard, Seepage	1987	5	22	23%	S2	GNR	NA	
Lake—Deep, Soft, Seepage	1982	6	49	12%	S3	GNR	NA	
Lake—Hard Bog	1981	3	18	17%	S2	GNR	NA	
Lake—Shallow, Hard, Drainage	1982	1	35	3%	SU	GNR	NA	
Lake—Shallow, Hard, Seepage	1985	6	52	12%	SU	GNR	NA	
Lake—Shallow, Soft, Drainage	1984	1	36	3%	S3	GNR	NA	
Lake—Shallow, Soft, Seepage	1985	14	87	16%	S4	GNR	NA	
Lake—Soft Bog	2006	7	52	13%	S4	GNR	NA	
Lake—Spring	1992	2	13	15%	S3	GNR	NA	
Moist Cliff	1985	4	176	2%	S4	GNR	NA	
Muskeg	2007	5	45	11%	S4	G4G5	NA	
Northern Dry Forest	1978	3	63	5%	S3	G3?	NA	
Northern Dry-mesic Forest	2006	35	284	12%	S3	G4	NA	
Northern Mesic Forest	2007	95	383	25%	S4	G4	NA	
Northern Sedge Meadow	2008	35	231	15%	S3	G4	NA	
Northern Wet Forest	2007	47	322	15%	S4	G4	NA	

Continued on next page

Appendix 11.C, *continued.*

Scientific name (common name)	Lastobs Date	EOs[a] in FT	EOs in WI	Percent in FT	State rank	Global rank	State status	Federal status
Northern Wet-mesic Forest	2007	56	243	23%	S3S4	G3?	NA	
Oak Barrens	1992	1	38	3%	S2	G2?	NA	
Open Bog	2000	27	173	16%	S4	G5	NA	
Poor Fen	2007	3	46	7%	S3	G3G4	NA	
Shrub-carr	2007	3	143	2%	S4	G5	NA	
Southern Dry Forest	1984	1	97	1%	S3	G4	NA	
Southern Dry-mesic Forest	2006	10	293	3%	S3	G4	NA	
Southern Mesic Forest	2000	5	221	2%	S3	G3?	NA	
Southern Sedge Meadow	2005	2	182	1%	S3	G4?	NA	
Southern Tamarack Swamp (Rich)	2000	2	32	6%	S3	G3	NA	
Spring Pond	2007	15	69	22%	S3	GNR	NA	
Springs and Spring Runs, Hard	2007	8	71	11%	S4	GNR	NA	
Springs and Spring Runs, Soft	1981	1	12	8%	SU	GNR	NA	
Stream—Fast, Hard, Cold	1983	35	98	36%	S4	GNR	NA	
Stream—Fast, Hard, Warm	1982	2	10	20%	SU	GNR	NA	
Stream—Fast, Soft, Cold	1981	3	15	20%	SU	GNR	NA	
Stream—Fast, Soft, Warm	1985	1	5	20%	SU	GNR	NA	
Stream—Slow, Hard, Cold	1982	6	22	27%	SU	GNR	NA	
Stream—Slow, Hard, Warm	1984	4	20	20%	SU	GNR	NA	
Stream—Slow, Soft, Warm	1983	2	14	14%	SU	GNR	NA	
Tamarack (Poor) Swamp	2007	3	33	9%	S3	G4	NA	
OTHER ELEMENTS								
Bird rookery	2007	4	54	7%	SU	G5	SC	
Mussel bed	2003	1	27	4%	S3?	G3	SC	

[a]An element occurrence is an area of land and/or water in which a rare species or natural community is, or was, present. Element occurrences must meet strict criteria that is used by an international network of Heritage programs and coordinated by NatureServe.

[b]Northern long-eared bat (*Myotis septentrionalis*) was listed as Wisconsin Threatened on 6/01/2011 and as U.S. Threatened on 5/04/2015.

[c]The common names of birds are capitalized in accordance with the checklist of the American Ornithologists Union.

[d]The American Ornithologist's Union lists these warblers as Canada Warbler (*Cardellina canadensis*), Cerulean Warbler (*Setophaga cerulea*), and Black-throated blue Warbler (*Setophaga caerulescens*).

[e]The snuffbox (*Epioblasma triquetra*) and spectacle case (*Cumberlandia monodonta*) mussels were listed as U.S. Endangered in 2012.

STATUS AND RANKING DEFINITIONS

U.S. Status—Current federal protection status designated by the Office of Endangered Species, U.S. Fish and Wildlife Service, indicating the biological status of a species in Wisconsin:

LE = listed endangered.

LT = listed threatened.

PE = proposed as endangered.

NEP = nonessential experimental population.

C = candidate for future listing.

CH = critical habitat.

State Status—Protection category designated by the Wisconsin DNR:

END = Endangered. Endangered species means any species whose continued existence as a viable component of this state's wild animals or wild plants is determined by the Wisconsin DNR to be in jeopardy on the basis of scientific evidence.

THR = Threatened species means any species of wild animals or wild plants that appears likely, within the foreseeable future, on the basis of scientific evidence to become endangered.

SC = Special Concern. Special Concern species are those species about which some problem of abundance or distribution is suspected but not yet proven. The main purpose of this category is to focus attention on certain species before they become threatened or endangered.

Wisconsin DNR and federal regulations regarding Special Concern species range from full protection to no protection. The current categories and their respective level of protection are as follows:

SC/P = fully protected;

SC/N = no laws regulating use, possession, or harvesting;

SC/H = take regulated by establishment of open closed seasons;

SC/FL = federally protected as endangered or threatened but not so designated by Wisconsin DNR;

SC/M = fully protected by federal and state laws under the Migratory Bird Act.

Status and ranking definitions continued on next page

Appendix 11.C, *continued.*

Global Element Ranks:

G1 = Critically imperiled globally because of extreme rarity (5 or fewer occurrences or very few remaining individuals or acres) or because of some factor(s) making it especially vulnerable to extinction.

G2 = Imperiled globally because of rarity (6 to 20 occurrences or few remaining individuals or acres) or because of some factor(s) making it very vulnerable to extinction throughout its range.

G3 = Either very rare and local throughout its range or found locally (even abundantly at some of its locations) in a restricted range (e.g., a single state or physiographic region) or because of other factor(s) making it vulnerable to extinction throughout its range; typically 21-100 occurrences.

G4 = Uncommon but not rare (although it may be quite rare in parts of its range, especially at the periphery) and usually widespread. Typically > 100 occurrences.

G5 = Common, widespread, and abundant (although it may be quite rare in parts of its range, especially at the periphery). Not vulnerable in most of its range.

GH = Known only from historical occurrence throughout its range, with the expectation that it may be rediscovered.

GNR = Not ranked. Replaced G? rank and some GU ranks.

GU = Currently unrankable due to lack of data or substantially conflicting data on status or trends. Possibly in peril range-wide, but status is uncertain.

GX = Presumed to be extinct throughout its range (e.g., Passenger pigeon) with virtually no likelihood that it will be rediscovered.

Species with a questionable taxonomic assignment are given a "Q" after the global rank. Subspecies and varieties are given subranks composed of the letter "T" plus a number or letter. The definition of the second character of the subrank parallels that of the full global rank. (Examples: a rare subspecies of a rare species is ranked G1T1; a rare subspecies of a common species is ranked G5T1.)

State Element Ranks:

S1 = Critically imperiled in Wisconsin because of extreme rarity, typically 5 or fewer occurrences and/or very few (<1,000) remaining individuals or acres, or due to some factor(s) making it especially vulnerable to extirpation from the state.

S2 = Imperiled in Wisconsin because of rarity, typically 6–20 occurrences and/or few (1,000– 3,000) remaining individuals or acres, or due to some factor(s) making it very vulnerable to extirpation from the state.

S3 = Rare or uncommon in Wisconsin, typically 21–100 occurrences and/or 3,000–10,000 individuals.

S4 = Apparently secure in Wisconsin, usually with > 100 occurrences and > 10,000 individuals.

S5 = Demonstrably secure in Wisconsin and essentially ineradicable under present conditions.

SNA = Accidental, nonnative, reported but unconfirmed, or falsely reported.

SH = Of historical occurrence in Wisconsin, perhaps having not been verified in the past 20 years and suspected to be still extant. Naturally, an element would become SH without such a 20-year delay if the only known occurrence were destroyed or if it had been extensively and unsuccessfully looked for.

SNR = Not Ranked; a state rank has not yet been assessed.

SU = Currently unrankable. Possibly in peril in the state, but status is uncertain due to lack of information or substantially conflicting data on status or trends.

SX = Apparently extirpated from the state.

State ranking of long-distance migrant animals:

Ranking long distance aerial migrant animals presents special problems relating to the fact that their nonbreeding status (rank) may be quite different from their breeding status, if any, in Wisconsin. In other words, the conservation needs of these taxa may vary between seasons. In order to present a less ambiguous picture of a migrant's status, it is necessary to specify whether the rank refers to the breeding (B) or nonbreeding (N) status of the taxon in question. (e.g., S2B, S5N).

Appendix 11.D. *Number of species with special designations documented within the Forest Transition Ecological Landscape, 2009.*

Listing status[a]	Taxa: Mammals	Birds	Herptiles	Fishes	Invertebrates	Total fauna	Total flora	Total listed
U.S. Endangered	1	0	0	0	3	4	0	4
U.S. Threatened	0	0	0	0	0	0	0	0
U.S. Candidate	0	0	0	0	1	1	0	1
Wisconsin Endangered	0	4	1	2	9	16	3	19
Wisconsin Threatened	0	5	2	8	7	22	9	31
Wisconsin Special Concern	6	11	3	9	28	57	43	100
Natural Heritage Inventory total	**6**	**20**	**6**	**19**	**44**	**95**	**55**	**150**

Note: State-listed species always include federally listed species (although they may not have the same designation); therefore, federally listed species are not included in the total.

[a]Snuffbox (*Epioblasma triquetra*) and spectacle case (*Cumberlandia monodonta*) mussels were listed as U.S. Endangered in 2012; northern long-eared bat (*Myotis septentrionalis*) was listed as Wisconsin Threatened in 2011 and as U.S. Threatened in 2015. These species are not included in the numbers above.

Appendix 11.E. *Species of Greatest Conservation Need (SGCN) found in the Forest Transition Ecological Landscape.*

These SGCN have a high or moderate probability of being found in this ecological landscape and use habitats that have the best chance for management here. Data are from the Wisconsin Wildlife Action Plan (WDNR 2005b) and Appendix E, "Opportunities for Sustaining Natural Communities in Each Ecological Landscape," in Part 3, "Supporting Materials." For more complete and/or detailed information, please see the Wisconsin Wildlife Action Plan. The Wildlife Action Plan is meant to be dynamic and will be periodically updated to reflect new information; the next update is planned for 2015.

Only SGCN highly or moderately (H = high association, M = moderate association) associated with specific community types or other habitat types and that have a high or moderate probability of occurring in the ecological landscape are included here (SGCN with a low affinity with a community type or other habitat type and with low probability of being associated with this ecological landscape were excluded). Only community types designated as "Major" or "Important" management opportunities for the ecological landscape are shown.

Greater Prairie-chicken.
Photo courtesy U.S. Fish and Wildlife Service.

	MAJOR								IMPORTANT														
	Coldwater Streams	Coolwater Streams	Impoundments/Reservoirs	Northern Mesic Forest	Northern Wet Forest	Northern Wet-mesic Forest	Warmwater Rivers	Warmwater Streams	Alder Thicket	Bedrock Glade	Dry Cliff	Emergent Marsh	Ephemeral Pond	Floodplain Forest	Inland Lakes	Moist Cliff	Northern Dry-mesic Forest	Northern Hardwood Swamp	Northern Sedge Meadow	Open Bog	Shrub Carr	Submergent Marsh	Surrogate Grasslands
Species that are Significantly Associated with the Forest Transition Ecological Landscape																							
MAMMALS																							
Eastern red bat	H	H		M	M	M	M	M	M			M	H	M	M		M	M	M	M	M	M	
BIRDS[a]																							
American Bittern												H							H	H			
American Golden Plover			M									M											M
American Woodcock				M					H									M			H		
Bald Eagle			H				H								H							M	
Black Tern			M									H			M				M			M	
Black-billed Cuckoo				M					H					M							H		
Black-throated Blue Warbler				H													M						
Blue-winged Teal			M									H		M	M				M			M	M
Bobolink																			H	M			H
Brown Thrasher																							M
Eastern Meadowlark																							H
Field Sparrow																							M
Golden-winged Warbler				M	M				H								M	M		M	H		
Greater Prairie-Chicken																			M				H
Least Flycatcher				H										M			M	M					
Lesser Scaup			M				M								M							H	
Northern Harrier																			H	M			H
Osprey			H				H								H								
Red-headed Woodpecker														M									
Red-shouldered Hawk				M									H	H			M						
Short-billed Dowitcher			M									H											
Trumpeter Swan			M									H			M							H	

Continued on next page

Appendix 11.E, *continued.*


Wood turtle. Photo by Wisconsin DNR staff.

	MAJOR								IMPORTANT														
	Coldwater Streams	Coolwater Streams	Impoundments/Reservoirs	Northern Mesic Forest	Northern Wet Forest	Northern Wet-mesic Forest	Warmwater Rivers	Warmwater Streams	Alder Thicket	Bedrock Glade	Dry Cliff	Emergent Marsh	Ephemeral Pond	Floodplain Forest	Inland Lakes	Moist Cliff	Northern Dry-mesic Forest	Northern Hardwood Swamp	Northern Sedge Meadow	Open Bog	Shrub Carr	Submergent Marsh	Surrogate Grasslands
Veery				M	M				H					M			M	H			H		
Vesper Sparrow																							
Whip-poor-will										M							M						
Wood Thrush				M										M									
HERPTILES																							
Four-toed salamander	M	M		H	M	H			H			H	H	H				M	M	H	H		
Wood turtle	H	H		H	M	M	H	H	H				M	H				M	M		H	H	
FISH																							
Black redhorse							H																
Ozark minnow								H															
Redfin shiner			M				H	M															
Species that are Moderately Associated with the Forest Transition Ecological Landscape																							
MAMMALS																							
Franklin's ground squirrel																							M
Gray wolf				H	H	H			H					M			H	M		M	M		
Hoary bat	H	H		M	M	M	M	M	M			M	H	M	M		M	M	M	M	M	M	
Northern flying squirrel				H	H	H								M			H	M					
Northern long-eared bat	H	H		M			M	M	M			M	H	M	M		M	M	M	M	M	M	
Silver-haired bat	H	H		M	M	M	M	M	M			M	H	M	M		M	M	M	M	M	M	
Water shrew	H	H		M	H	H		M	M					M	M			H					
Woodland jumping mouse				H	M	M							M	M				M					
BIRDS																							
Acadian Flycatcher														M									
Blue-winged Warbler										M				M							M		
Buff-breasted Sandpiper												M											M
Canada Warbler				M	M	H			M								M	H					
Canvasback			M				H								M							H	
Cerulean Warbler														H									
Dickcissel																							H
Dunlin			M				M					M											
Grasshopper Sparrow																							H
Henslow's Sparrow																				M			H
Hudsonian Godwit												H											
Le Conte's Sparrow																			H	M			H
Louisiana Waterthrush	H	H																					

Continued on next page

Appendix 11.E, *continued.*

Northern Goshawk.
Photo by Karen Laubenstein, U.S. Fish & Wildlife Service.

	MAJOR								IMPORTANT														
	Coldwater Streams	Coolwater Streams	Impoundments/Reservoirs	Northern Mesic Forest	Northern Wet Forest	Northern Wet-mesic Forest	Warmwater Rivers	Warmwater Streams	Alder Thicket	Bedrock Glade	Dry Cliff	Emergent Marsh	Ephemeral Pond	Floodplain Forest	Inland Lakes	Moist Cliff	Northern Dry-mesic Forest	Northern Hardwood Swamp	Northern Sedge Meadow	Open Bog	Shrub Carr	Submergent Marsh	Surrogate Grasslands
Northern Goshawk				H													M						
Rusty Blackbird									M			M	M	H						M	M		
Solitary Sandpiper	M	M						M				H	H	H						M			
Upland Sandpiper																							H
Western Meadowlark																							H
Yellow Rail																			H	H			
Yellow-billed Cuckoo														H							M		
HERPTILES																							
Mudpuppy	M		H				H								H								
Northern prairie skink										H	M						M						
Pickerel frog	H	H	H	M	M	M	H	H	M			H	H	M	M				H	M	M	H	
FISH																							
Redside dace	M	M						M															

[a]The common names of birds are capitalized in accordance with the checklist of the American Ornithologists Union.

Appendix 11.F. *Natural communities[a] for which there are management opportunities in the Forest Transition Ecological Landscape.*

Major opportunity[b]	Important opportunity[c]	Present[d]
Northern Mesic Forest	Northern Dry-Mesic Forest	Southern Mesic Forest
Northern Wet-Mesic Forest	Northern Hardwood Swamp	
Northern Wet Forest	Floodplain Forest	Southern Sedge Meadow
	Southern Dry-mesic Forest	
Coldwater Stream		Emergent Marsh – Wild Rice
Coolwater Stream	Alder Thicket	
Impoundment/Reservoir	Shrub-carr	
Warmwater River		
Warmwater Stream	Northern Sedge Meadow	
	Surrogate Grasslands	
	Open Bog (includes Muskeg, Poor Fen)	
	Emergent Marsh	
	Submergent Marsh	
	Ephemeral Pond	
	Bedrock Glade	
	Dry Cliff (Curtis' Exposed Cliff)	
	Moist Cliff (Curtis' Shaded Cliff)	
	Inland Lake	

[a]See Chapter 7, "Natural Communities, Aquatic Features, and Selected Habitats of Wisconsin," for definitions of natural community types. Also see Appendix E, "Opportunities for Sustaining Natural Communities in Each Ecological Landscape," in Part 3 ("Supporting Materials") for an explanation on how the information in this table can be used.

[b]Major opportunity – Relatively abundant, represented by multiple significant occurrences, or ecological landscape is appropriate for major restoration activities.

[c]Important opportunity – Less abundant but represented by one to several significant occurrences or type is restricted to one or a few ecological landscapes.

[d]Present – Uncommon or rare, with no good occurrences documented. Better opportunities are known to exist in other ecological landscapes, or opportunities have not been adequately evaluated.

Appendix 11.G. *Public conservation lands in the Forest Transition Ecological Landscape, 2005.*

Property name	Size (acres)[a]
STATE	
Ackley State Wildlife Area	1,100
Amsterdam Sloughs State Wildlife Area[b]	375
Balsam Branch State Wildlife Area	175
Beaver Brook State Wildlife Area	1,280
Behning Creek State Fishery Area	120
Big Rib River State Fishery Area	730
Bill Cross State Wildlife Area[b]	330
Chippewa Moraine State Recreation Area[b]	235
Clam River State Fishery Area[b]	1,900
Council Grounds State Park	480
Dewey Marsh State Wildlife Area[b]	840
Duncan Creek State Fishery Area	360
Emmons Creek State Fishery Area[b]	280
Engle Creek Springs State Fishery Area	190
Evergreen River State Fishery Area	1,060
Hartman Creek State Park[b]	1,010
Hay Creek State Fishery Area	230
Interstate State Park	430
Joel Marsh State Wildlife Area	1,225
Lake Wissota State Park	1,050
Little Wolf River State Fishery Area	2,360
Loon Lake State Wildlife Area	2,850
McKenzie Creek State Wildlife Area	5,550
McMillan State Wildlife Area	4,140
McCann Creek State Fishery Area	430
Mead State Wildlife Area	27,630
Myklebust Lake State Natural Area	170
New Auburn State Wildlife Area[b]	1,020
Parker Creek State Fishery Area	190
Paul Olson State Wildlife Area[b]	870
Plover River State Fishery Area	1,450
Prairie River State Fishery Area[b]	1,350
Rabes Lake State Fishery Area	120
Rib Mountain State Park	1,180
Rib River State Fishery Area	170
Rice Beds Creek State Wildlife Area	3,130
Richard A Hemp State Fishery Area[b]	1,220
Sand Creek State Fishery Area[b], Chippewa County	195
Sand Creek State Fishery Area, Polk County	1,400
Sawyer Creek State Fishery Area[b]	640
Spring Lake State Fishery Area	240
Ten Mile Creek State Wildlife Area	410
Tom Lawin State Wildlife Area[b]	1,440
Trout-Nace Creek State Fishery Area	170
Upper Wolf River State Fishery Area[b]	3,180
Woods Flowage State Fishery Area	1,220
Yellow River State Fishery Area	700
Miscellaneous Lands[c]	10,490
FEDERAL	
Chequamegon-Nicolet National Forest[b]	81,200
St. Croix National Scenic Riverway[b]	2,720
Waterfowl Production Areas	830

Continued on next page

Appendix 11.G, *continued.*

Property name	Size (acres)[a]
COUNTY FOREST[d]	
Barron County Forest[b]	9,020
Burnett County Forest[b]	3,790
Chippewa County Forest[b]	120
Clark County Forest[b]	9,700
Eau Claire County Forest[b]	1,190
Langlade County Forest[b]	37,810
Lincoln County Forest[b]	170
Marathon County Forest	24,760
Polk County Forest[b]	5,700
Rusk County Forest[b]	585
Sawyer County Forest[b]	670
Taylor County Forest[b]	3,970
Washburn County Forest[b]	17,520
TOTAL	**287,070**

Source: *Wisconsin Land Legacy Report* (WDNR 2006b).

[a]Actual acres owned in this ecological landscape.

[b]This property also falls within adjacent ecological landscape(s).

[c]Includes public access sites, fish hatcheries, fire towers, streambank and nonpoint easements, lands acquired under statewide wildlife, fishery, forestry, and natural area programs, Board of Commissioners of Public Lands holdings, small properties under 100 acres, and properties with fewer than 100 acres within this ecological landscape.

[d]Locations and sizes of county-owned parcels enrolled in the Forest Crop Law program are presented here. Information on locations and sizes of other county and local parks in this ecological landscape is not readily available and is not included here, except for some very large properties.

Appendix 11.H. *Land Legacy places in the Forest Transition Ecological Landscape and their ecological and recreational significance.*

The *Wisconsin Land Legacy Report* (WDNR 2006b) identified 33 places in the Forest Transition Ecological Landscape that merit conservation action based upon a combination of ecological significance and recreational potential.

Map Code	Place name	Size	Protection initiated	Protection remaining	Conservation significance[a]	Recreation potential[b]
AR	Apple River	Small	Moderate	Moderate	xx	xxx
BV	Balsam Branch Creek and Woodlands	Small	Limited	Moderate	x	xxx
BW	Big Eau Pleine River and Woods	Medium	Limited	Substantial	xx	xxx
BC	Big Rock Creek	Small	Limited	Moderate	xx	xxx
BR	Black River	Large	Limited	Substantial	xxx	xxx
CG	Central Wisconsin Grasslands	Large	Moderate	Moderate	xxxx	xxx
CN	Chequamegon-Nicolet National Forests	Large	Substantial	Limited	xxxx	xxxxx
CL	Chippewa Glacial Lakes	Large	Substantial	Moderate	xxxx	xxxxx
CR	Clam River	Medium	Moderate	Substantial	xxx	xxxx
CT	Comet Creek and Woodlands	Small	Limited	Substantial	xxx	xx
DW	Dewey Marsh and Woods	Small	Moderate	Limited	xxx	xxx
EC	East and West Branches of the Eau Claire River	Medium	Moderate	Moderate	xx	xxx
HE	Hartman & Emmons Creeks	Small	Substantial	Limited	xxx	xxx
HB	Haugen-Birchwood Lakeland	Large	Substantial	Moderate	xxx	xxxx
HR	Hay River	Medium	Limited	Substantial	xxxx	xxxx
MC	Menominee County Forests	Large	Substantial	Limited	xxxxx	x
MW	Middle Wisconsin River	Large	Limited	Substantial	xxx	xxxx
NH	Norrie-Hatley Wetlands	Small	Limited	Moderate	xxx	xx
PV	Plover River	Medium	Limited	Substantial	xxx	xxx
PR	Prairie River	Medium	Moderate	Substantial	xxxx	xxx
RD	Red River	Medium	Limited	Substantial	xxx	xxx
RB	Rib River	Medium	Moderate	Moderate	xx	xxx
SC	Sand Country trout streams	Large	Substantial	Moderate	xxxx	xxxx
SX	St. Croix River	Large	Substantial	Limited	xxxxx	xxxx
SR	Straight River Channel	Medium	Limited	Substantial	xxxxx	xxx
TA	Trade River Wetlands	Small	Limited	Moderate	xxx	x
UC	Upper Chippewa River	Large	Limited	Substantial	xxxxx	xxxx
UD	Upper Red Cedar River	Medium	Limited	Substantial	xxxx	xxxx
UP	Upper Wolf River	Large	Substantial	Moderate	xxxxx	xxxx
UY	Upper Yellow River	Small	Moderate	Moderate	xxx	xxx
YC	Yellow (Chippewa) River	Medium	Limited	Moderate	xxx	xx
YW	Yellow (Wisconsin) River	Large	Moderate	Moderate	xxxxx	xx
NS	North Branch of the Embarrass River	Small	Limited	Substantial	xxx	xx

[a]**Conservation significance.** See the *Wisconsin Land Legacy Report* (WDNR 2006b), p. 43, for detailed discussion.

xxxxx Possesses outstanding ecological qualities, is large enough to meet the needs of critical components, and/or harbors globally or continentally significant resources. Restoration, if needed, has a high likelihood of success.

xxxx Possesses excellent ecological qualities, is large enough to meet the needs of most critical components, and/or harbors continentally or Great Lakes regionally significant resources. Restoration has a high likelihood of success.

xxx Possesses very good ecological qualities, is large enough to meet the needs of some critical components, and/or harbors statewide significant resources. Restoration will typically be important and has a good likelihood of success.

xx Possesses good ecological qualities, may be large enough to meet the needs of some critical components, and/or harbors statewide or ecological landscape significant resources. Restoration is likely needed and has a good chance of success.

x Possesses good to average ecological qualities, may be large enough to meet the needs of some critical components, and/or harbors ecological landscape significant resources. Restoration is needed and has a reasonable chance of success.

Continued on next page

Appendix 11.H, *continued.*

[b]**Recreation potential.** See the *Wisconsin Land Legacy Report,* p. 43, for detailed discussion.

xxxxx Outstanding recreation potential, could offer a wide variety of land and water-based recreation opportunities, could meet many current and future recreation needs, is large enough to accommodate incompatible activities, could link important recreation areas, and/or is close to state's largest population centers.

xxxx Excellent recreation potential, could offer a wide variety of land and water-based recreation opportunities, could meet several current and future recreation needs, is large enough to accommodate some incompatible activities, could link important recreation areas, and/or is close to large population centers.

xxx Very good recreation potential, could offer a variety of land and/or water-based recreation opportunities, could meet some current and future recreation needs, may be large enough to accommodate some incompatible activities, could link important recreation areas, and/or is close to mid-sized to large population centers.

xx Good to moderate recreation potential, could offer some land and/or water-based recreation opportunities, might meet some current and future recreation needs, may not be large enough to accommodate some incompatible activities, could link important recreation areas, and/or is close to mid-sized population centers.

x Limited recreation potential, could offer a few land and/or water-based recreation opportunities, might meet some current and future recreation needs, is not likely large enough to accommodate some incompatible activities, could link important recreation areas, and/or is close to small population centers.

Appendix 11.I. *Importance of economic sectors (based on the number of jobs) within the Forest Transition counties compared to the rest of the state.*

Industry	CLMC	CSH	CSP	FT	NCF	NES	NH	NLMC	NWL	NWS	SEGP	SLMC	SWS	SCP	WCR	WP
Agriculture, Fishing & Hunting	0.87	2.14	2.41	2.15	2.15	1.90	0.50	2.71	0.43	1.29	0.76	0.10	4.46	0.87	2.36	2.30
Forest Products & Processing	1.64	0.98	1.83	2.40	3.43	2.20	1.33	1.74	0.41	1.07	0.65	0.32	0.45	1.44	0.96	0.69
Mining	1.08	1.64	0.79	0.79	2.69	3.55	0.91	2.16	0.16	0.34	1.47	0.19	0.62	0.08	0.77	1.21
Utilities	2.44	1.08	0.81	0.39	0.61	0.45	0.58	0.41	1.96	1.76	0.67	0.65	0.81	1.83	1.19	0.51
Construction	1.12	1.02	0.89	0.96	1.14	0.92	2.38	1.08	1.07	1.14	1.08	0.67	0.98	1.13	1.03	1.11
Manufacturing (non-wood)	1.23	1.02	0.74	0.98	0.90	1.37	0.21	1.15	0.49	0.59	1.19	0.87	0.78	0.46	0.77	0.99
Wholesale Trade	0.99	0.63	0.61	0.95	0.62	0.53	0.47	0.60	1.15	0.72	1.16	0.98	0.89	0.76	0.83	0.53
Retail Trade	1.01	1.00	0.99	1.11	1.11	1.00	1.66	1.03	1.30	1.19	1.02	0.80	1.69	1.11	1.11	1.13
Tourism-related	0.99	1.12	0.97	0.86	0.99	1.05	1.51	1.28	1.34	1.41	0.94	1.02	0.78	1.33	1.08	1.12
Transportation & Warehousing	0.95	1.32	2.13	1.40	1.19	1.15	0.80	0.89	3.25	2.15	0.82	0.83	0.74	2.12	1.39	0.99
Information	0.76	0.49	0.69	0.74	0.58	0.68	0.80	0.70	0.38	0.49	1.22	1.11	1.09	0.64	0.62	0.57
Finance & Insurance	1.22	1.31	0.89	0.96	0.56	0.46	0.43	0.48	0.47	0.46	1.04	1.18	0.65	0.45	0.70	0.55
Real Estate, Rental & Leasing	0.84	0.73	0.59	0.60	0.52	0.34	1.37	0.95	0.42	0.50	1.17	1.14	0.47	0.46	0.87	0.66
Pro, Science & Tech Services	0.85	0.53	0.46	0.55	0.41	0.36	0.43	0.45	0.51	0.47	1.04	1.51	0.49	0.47	0.63	0.81
Management	0.80	0.26	0.63	0.54	0.37	0.21	0.17	0.24	0.65	0.47	0.94	1.62	0.08	0.64	0.87	0.45
Admin, Support, Waste, & Remediation	0.99	0.42	0.43	0.46	0.34	0.23	0.61	0.34	0.61	0.43	0.92	1.64	0.58	0.51	0.70	0.63
Private Education	0.86	0.68	0.39	0.42	0.86	0.72	0.87	0.55	0.08	0.12	0.80	1.94	0.09	1.53	0.68	0.55
Health Care & Social Services	0.85	0.88	1.27	1.04	0.82	0.90	0.87	0.84	0.96	0.91	0.83	1.32	0.84	0.99	1.09	0.94
Other Services	1.08	1.32	1.10	1.05	1.10	1.13	1.25	1.19	1.36	1.09	1.06	0.84	1.14	1.13	0.91	1.29
Government	0.78	1.09	1.11	1.03	1.26	1.36	1.08	1.03	1.36	1.54	1.04	0.89	1.15	1.50	1.14	1.21

Source: Based on an economic base analysis using location quotients (Quintero 2007). Definitions of economic sectors can be found at the U.S. Census Bureau's North American Industry Classification System web page (USCB 2013).

Appendix 11.J. *Scientific names of species mentioned in the text.*

Common name	Scientific name
American basswood	*Tilia americana*
American beaver	*Castor canandensis*
American beech	*Fagus grandifolia*
American Bittern[a]	*Botaurus lentiginosus*
American black bear	*Ursus americanus*
American elm	*Ulmus americana*
American Golden-Plover	*Pluvialis dominica*
American Woodcock	*Scolopax minor*
Annosum root rot fungus	*Heterobasidion annosum*
Ashes	*Fraxinus* spp.
Asian wild rice	*Zizania latifolia*
Aspen heart rot fungus	*Phellinus tremulae*
Aspen hypoxylon canker fungus	*Hypoxylon mammatum*
Aspens	*Populus* spp.
Assiniboine sedge	*Carex assiniboinensis*
Bald Eagle	*Haliaeetus leucocephalus*
Balsam fir	*Abies balsamea*
Banded killifish	*Fundulus diaphanous*
Bank Swallow	*Riparia riparia*
Barn Owl	*Tyto alba*
Belted Kingfisher	*Megaceryle alcyon*
Birches	*Betula* spp.
Black ash	*Fraxinus nigra*
Black-billed Cuckoo	*Coccyzus erythropthalmus*
Black buffalo	*Ictiobus niger*
Blackburnian Warbler	*Setophaga fusca*
Black crappie	*Pomoxis nigromaculatus*
Black locust	*Robinia pseudoacacia*
Black spruce	*Picea mariana*
Black redhorse	*Moxostoma duquesnei*
Black-throated Blue Warbler	*Setophaga caerulescens*, listed as *Dendroica caerulescens* on the Wisconsin Natural Heritage Working List
Black-throated Green Warbler	*Setophaga virens*
Blanding's turtle	*Emydoidea blandingii*
Bluegill	*Lepomis macrochirus*
Blue-winged Teal	*Anas discors*
Blue sucker	*Cycleptus elongatus*
Bobcat	*Lynx rufus*
Bobolink	*Dolichonyx oryzivorus*
Bog bluegrass	*Poa paludigena*
Brittle prickly-pear	*Opuntia fragilis*
Bronze birch borer	*Agrilus anxius*
Brook trout	*Salvelinus fontinalis*
Brown Thrasher	*Toxostoma rufum*
Brown trout	*Salmo trutta*
Buckhorn mussel	*Tritogonia verrucosa*
Butterfly mussel	*Ellipsaria lineolata*
Canada thistle	*Cirsium arvense*
Canada Warbler	*Cardellina canadensis*, listed as *Wilsonia canadensis* on the Wisconsin Natural Heritage Working List
Cerulean Warbler	*Setophaga cerulea*, listed as *Dendroicia cerulea* on the Wisconsin Natural Heritage Working List
Chestnut-sided Warbler	*Setophaga pensylvanica*
Cliff Swallow	*Petrochelidon pyrrhonota*
Common buckthorn	*Rhamnus cathartica*

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Appendix 11.J, *continued.*

Common name	Scientific name
Common carp	*Cyprinus carpio*
Common Loon	*Gavia immer*
Common reed	*Phragmites australis*
Common tansy	*Tanacetum vulgare*
Cougar	*Puma concolor*
Crawling water beetle	*Haliplus pantherinus*
Crystal darter	*Crystallaria asprella*
Curly pondweed	*Potamogeton crispus*
Cut-leaved toothwort	*Cardamine concatenata*
Dame's rocket	*Hesperis matronalis*
Dickcissel	*Spiza americana*
Diplodia pine blight fungus	*Diplodia pinea*
Dwarf huckleberry	*Vaccinium cespitosum*
Dunlin	*Calidris alpina*
Dutch elm disease fungus	*Ophiostoma ulmi*
Dwarf ginseng	*Panex trifolius*
Eastern hemlock	*Tsuga canadensis*
Eastern Meadowlark	*Sturnella magna*
Eastern red bat	*Lasiurus borealis*
Eastern white pine	*Pinus strobus*
Eastern Wood-Pewee	*Contopus virens*
Elephant ear mussel	*Elliptio crassidens*
Elktoe	*Alasmidonta marginata*
Ellipse	*Venustaconcha ellipsiformis*
Elms	*Ulmus* spp.
Elm bark beetles	*Hylurgopinus rufipes* and *Scolytus multistriatus*
Emerald ash borer	*Agrilus planipennis*
Eurasian honeysuckles	*Lonicera tatarica*, *L. morrowii*, and *L.* x *bella*
Eurasian water-milfoil	*Myriophyllum spicatum*
European earthworms	Family Lumbricidae
Field Sparrow	*Spizella pusilla*
Fisher	*Martes pennanti*
Forest tent caterpillar	*Malacosoma disstria*
Four-toed salamander	*Hemidactylium scutatum*
Fragrant fern	*Dryopteris fragrans* var. *remotiuscula*
Garlic mustard	*Alliaria petiolata*
Gilt darter	*Percina evides*
Glossy buckthorn	*Rhamnus frangula*
Golden-winged Warbler	*Vermivora chrysoptera*
Grasshopper Sparrow	*Ammodramus savannarum*
Gray wolf	*Canis lupus*
Great Blue Heron	*Ardea herodias*
Greater Prairie-Chicken	*Tympanuchus cupido*
Greater redhorse	*Moxostoma valenciennesi*
Green ash	*Fraxinus pennsylvanica*
Gypsy moth	*Lymantria dispar*
Henslow's Sparrow	*Ammodramus henslowii*
Hermit Thrush	*Catharus guttatus*
Higgins' eye	*Lampsilis higginsii*
Hoary bat	*Lasiurus cinereus*
Hooded Merganser	*Lophodytes cucullatus*
Indian cucumber-root	*Medeola virginiana*
Jack pine	*Pinus banksiana*
Jack pine budworm	*Choristoneura pinus*
Japanese barberry	*Berberis thunbergii*

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Appendix 11.J, *continued.*

Common name	Scientific name
Japanese knotweed	*Polygonum cuspidatum*
Karner blue butterfly	*Lycaeides melissa samuelis*
Lake darner	*Aeshna eremita*
Lake sturgeon	*Acipenser fulvescens*
Lancet clubtail	*Gomphus exilis*
Large-flowered bellwort	*Uvularia grandiflora*
Largemouth bass	*Micropterus salmoides*
Least Flycatcher	*Empidonax minimus*
Leafy spurge	*Euphorbia esula*
Leafy white orchis	*Platanthera dilatata*
Lilacs	*Syringa* spp.
Little goblin moonwort fern	*Botrychium mormo*
Loggerhead Shrike	*Lanius ludovicianus*
Louisiana Waterthrush	*Parkesia motacilla*, listed as *Seiurus motacilla* on the Wisconsin Natural Heritage Working List
Mallard	*Anas platyrhynchos*
Maples	*Acer* spp.
Marsh valerian	*Valeriana sitchensis* ssp. *uliginosa*
Marsh Wren	*Cistothorus palustris*
Monkeyface	*Quadrula metanevra*
Muskellunge	*Esox masquinongy*
Narrow-leaved cattail	*Typha angustifolia*
Nashville Warbler	*Oreothlypis ruficapilla*
North American river otter	*Lontra canadensis*
Northern blue butterfly	*Lycaeides idas*
Northern cricket frog	*Acris crepitans*
Northern flying squirrel	*Glaucomys sabrinus*
Northern Goshawk	*Accipiter gentilis*
Northern Harrier	*Circus cyaneus*
Northern long-eared bat	*Myotis septentrionalis*
Northern pike	*Esox lucius*
Northern red oak	*Quercus rubra*
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*
Northern white-cedar	*Thuja occidentalis*
Oaks	*Quercus* spp.
Oak wilt fungus	*Ceratocystis fagacearum*
Oregon cliff fern	*Woodsia oregana* var. *cathcartiana*
Osprey	*Pandion haliaetus*
Ottoe skipper	*Hesperia ottoe*
Ovenbird	*Seiurus aurocapilla*
Ozark minnow	*Notropis nubilus*
Passenger Pigeon	*Ectopistes migratorius*
Peregrine Falcon	*Falco peregrinus*
Pickerel frog	*Lithobates palustris*
Pines	*Pinus* spp.
Pine sawfly	*Neodiprion* spp., *Diprion* spp.
Privets	*Ligustrum* spp.
Prothonotary Warbler	*Protonotaria citrea*
Pugnose shiner	*Notropis anogenus*
Purple loosestrife	*Lythrum salicaria*
Purple wartyback	*Cyclonaias tuberculata*
Pygmy snaketail	*Ophiogomphus howei*
Rainbow trout	*Oncorhynchus mykiss*
Ram's-head lady's-slipper	*Cypripedium arietinum*
Redfin shiner	*Lythrurus umbratilis*

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Appendix 11.J, *continued.*

Common name	Scientific name
Red maple	*Acer rubrum*
Red-necked Grebe	*Podiceps grisegena*
Red pine	*Pinus resinosa*
Red pine pocket mortality fungi	*Leptographium terrebrantis* and *L. procerum*
Red-shouldered Hawk	*Buteo lineatus*
Redside dace	*Clinostomus elongatus*
Reed canary grass	*Phalaris arundinacea*
Regal fritellary	*Speyeria idalia*
River redhorse	*Moxostoma carinatum*
Round-leaved orchis	*Amerorchis rotundifolia*
Ruffed Grouse	*Bonasa umbellus*
Rusty crayfish	*Orconectes rusticus*
Saint Croix snaketail	*Ophiogomphus susbehcha*
Salamander mussel	*Simpsonaias ambigua*
Sand snaketail	*Ophiogomphus smithi*
Sharp-tailed Grouse	*Tympanuchus phasianellus*
Short-billed Dowitcher	*Limnodromus griseus*
Short-eared Owl	*Asio flammeus*
Siberian elm	*Ulmus pumila*
Silver-haired bat	*Lasionycteris noctivagans*
Slippershell	*Alasmidonta viridis*
Smallmouth bass	*Micropterus dolomieu*
Snuffbox	*Epioblasma triquetra*
Spectacle case	*Cumberlandia monodonta*
Spotted knapweed	*Centaurea biebersteinii*
Spotted pondweed	*Potamogeton pulcher*
Spring-beauty	*Claytonia virginica*
Spruces	*Picea* spp.
Saint Croix snaketail	*Ophiogomphus susbehcha*
Subarctic darner	*Aeshna subartica*
Sugar maple	*Acer saccharum*
Tamarack	*Larix laricina*
Trumpeter Swan	*Cygnus buccinator*
Two-lined chestnut borer	*Agrilus bilineatus*
Upland Sandpiper	*Bartramia longicauda*
Vasey's pondweed	*Potamogeton vaseyi*
Veery	*Catharus fuscescens*
Virginia waterleaf	*Hydrophyllum virginianum*
Walleye	*Sander vitreus*
Wartyback	*Quadrula nodulata*
Water scavenger beetle	*Laccobius agilis*
Water shrew	*Sorex palustris*
Watercress	*Nasturtium officinale*
Weed shiner	*Notropis texanus*
Western Meadowlark	*Sturnella neglecta*
West Virginia white butterfly	*Pieris virginiensis*
White adder's-mouth	*Malaxis monophyllos* var. *brachypoda*
White ash	*Fraxinus americana*
White birch	*Betula papyrifera*
White oak	*Quercus alba*
White pine blister rust fungus	*Cronartium ribicola*
White spruce	*Picea glauca*
White-tailed deer	*Odocoileus virginianus*
Wild leek	*Allium tricoccum*
Wild parsnip	*Pastinaca sativa*

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Appendix 11.J, *continued.*

Common name	Scientific name
Wild rice	*Zizania* spp.
Wild Turkey	*Meleagris gallopavo*
Willow Flycatcher	*Empidonax traillii*
Winged mapleleaf	*Quadrula fragosa*
Winter Wren	*Troglodytes hiemalis*
Wood Duck	*Aix sponsa*
Woodland jumping mouse	*Napaeozapus insignis*
Wood Thrush	*Hylocichla mustelina*
Wood turtle	*Glyptemys insculpta*
Yellow birch	*Betula alleghaniensis*
Yellow perch	*Perca flavescens*
Yellow Rail	*Coturnicops noveboracensis*
Yellow-throated Vireo	*Vireo flavifrons*
Zebra mussel	*Dreissena polymorpha*

[a]The common names of birds are capitalized in accordance with the checklist of the American Ornithologists Union.

Appendix 11.K. *Maps of important physical, ecological, and aquatic features within the Forest Transition Ecological Landscape.*

- Vegetation of the Forest Transition Ecological Landscape in the Mid-1800s
- Land Cover of the Forest Transition Ecological Landscape in the Mid-1800s
- Landtype Associations of the Forest Transition Ecological Landscape
- Public Land Ownership, Easements, and Private Land Enrolled in the Forest Tax Programs in the Forest Transition Ecological Landscape
- Ecologically Significant Places of the Forest Transition Ecological Landscape
- Exceptional and Outstanding Resource Waters and 303(d) Degraded Waters of the Forest Transition Ecological Landscape
- Dams of the Forest Transition Ecological Landscape
- WISCLAND Land Cover (1992) of the Forest Transition Ecological Landscape
- Soil Regions of the Forest Transition Ecological Landscape
- Relative Tree Density of the Forest Transition Ecological Landscape in the Mid-1800s
- Population Density, Cities, and Transportation of the Forest Transition Ecological Landscape

Note: *Go to http://dnr.wi.gov/topic/landscapes/index.asp?mode=detail&Landscape=10 and click the "maps" tab.*

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